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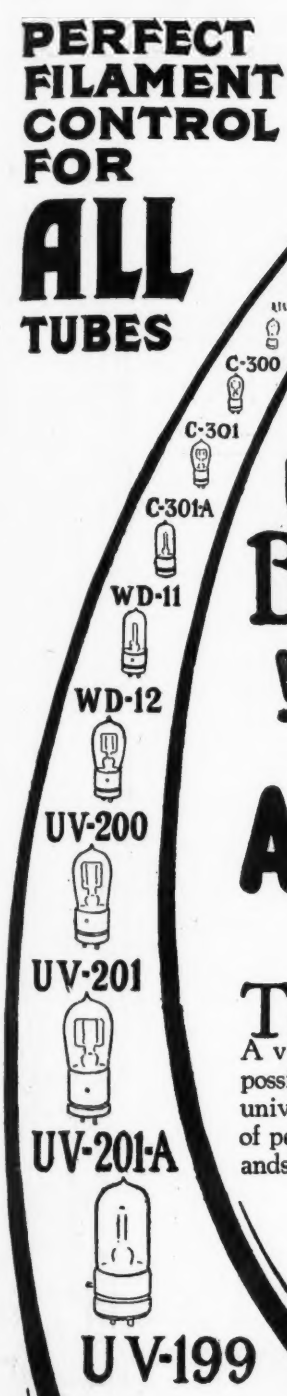

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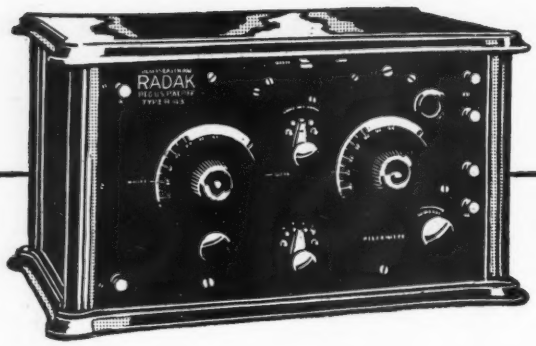

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RADIO NEWS

H. GERNSBACK—Editor and Publisher
ROBERT E. LACAULT—Associate Editor

EDITORIAL AND GENERAL OFFICES, 53 PARK PLACE, NEW YORK

Vol. 5 AUGUST, 1923 No. 2

Short Radio Waves

DURING the last decade we have as a rule employed for radio communications wave-lengths varying from 10,000 meters down to about 600 meters for commercial work. The broadcast era inaugurated about two years ago witnessed a reduction of this wave-length down to about 360 meters. Long before that time, American amateurs had been transmitting on a wave-length of 200 meters and although our radio experts told us that very long wave-lengths such as 10,000 meters and over were absolutely necessary for long distance work, such as trans-oceanic, the amateur proved with his puny wave-length that he could span the ocean with facility.

Over three years ago, in an editorial, we mentioned and prophesied that the greatest wonders in store for radio lie in short wave-lengths, and we seem to be just about coming to this. About a year ago Marconi made the announcement that he could send radio waves in any direction by means of parabolic wave reflectors. The wave-lengths he used were about 20 meters or thereabouts. This was a great step in advance. Recently Dr. E. F. Nichols, director of the Nela Research Laboratories and his Associate, J. D. Tear, went Marconi one better and actually produced a wave-length of a little less than 1/100th of an inch! This is most extraordinary because for the first time radio waves have been made to overlap heat waves. Heat waves of 1/175th of an inch have been obtained in the laboratory, so that *we have now actually merged radio waves into heat waves.*

Just what this statement means to the future of radio seems impossible to even dimly discern today. One can make the wildest guesses and will probably hit far below the mark. For instance, if we say that the future radio generator may be an ordinary burning candle, this may sound like a wild dream, nevertheless the results of Nichols and Tear will make such a thing possible. If the radio waves can be converted into heat waves, or rather intermingled with them, there is no reason why the flame of an ordinary candle cannot be made to give out radio waves by some sort of transformation which as yet we can only see dimly in the future.

On the practical side, the era of short waves is just dawning. Recent experiments of Dunmore and Engel, of the Bureau of Standards, have shown that an entirely new field may be opened by short wave-lengths of about 10 meters or less. Such wave-lengths can and will be used for house to house communications in low power radio telephony. These waves can be directed in a beam so that they will only go in one direction. In other words, they can be directed just as a light ray is directed, by a search light, with the advantage that the concentrated radio beams can be made to go much further than light rays.

Hertz, in his famous researches years ago, has shown that electro-magnetic waves—radio waves in other words—can be refracted exactly like light rays. By means of a huge lens made of pitch, Hertz actually focused a beam of radio waves upon a chosen spot. By means of a pitch prism he refracted his waves much as we refract light rays, through a crystal prism. Indeed Nichols and Tear used similar appliances; for instance, they used a focusing lens made of paraffin where Hertz used a lens made of pitch.

There is a tremendous field for research open to the amateur in the wave-lengths between 10 meters and 1 meter, and entirely new fields will be opening up once we avail ourselves of these new wave-lengths. For one thing, interference is practically done away with. Static, the enemy of all radio experimenters, entirely vanishes when such a wave-length as 10 meters is used. For communication between friends and for short distances, up to a few miles, a 10-meter wave-length is ideal and likely to bring out new and unsuspected phenomena. Unless all indications are wrong, there will be a general stampede down to the low wave-length during the next few years. It will be accompanied by entirely new varieties of instruments which we cannot even conceive of clearly today. This is certain, mainly because the frequencies for the low wave-lengths become truly enormous. Thus, for instance, the frequency for 350 meters with its number of oscillations is 856,628. On 200 meters, the frequency has already become 1,499,100 vibrations per second, while for wave-lengths of 10 meters, the frequency has gone up to the tremendous value of 29,982,000 oscillations per second.

H. GERNSBACK.

Short Wave Directive Radio Transmission*

By FRANCIS W. DUNMORE and FRANCIS H. ENGEL
Physicist and Assistant Physicist, Radio Laboratory, Bureau of Standards

Fig. 7. Ten-Meter Receiving Set. Note on the Mast the Single Turn Coupler and Detector Tube. The Amplifier May Be Seen on the Left Stool and the Heterodyne on the Right One.

WITH the rapidly increasing use of radio, both for communication and broadcasting purposes, there has arisen the need for some method of transmission which will be free from interference from other stations. For broadcasting, it is obvious that the ideal to be sought for is to reach the greatest number of people. For such broadcast transmission directive antennae are not suitable, but the use of directional antennae for the reception of broadcast radio telephone messages offers a means of reducing interference difficulties at a receiving station. For "point-to-point" communication, however, a method of transmission which restricts the transmitted wave to a comparatively small area is much desired and would have many applications.

There are many cases in which communication is desired between points not easily accessible, so that radio communication is the only practicable means. The use of a method of directive transmission greatly reduces the interference which such communication will cause. There are some new kinds of point-to-point radio communication which are now being developed, such as the transmission of photographs by radio and the remote control of mechanisms by radio, all of which applications can advantageously be carried on by directive transmission.

Another great advantage to be derived from the use of directional transmission (at very short wave-lengths) is the freedom from strays and other atmospheric electric disturbances. It is generally known that strays are less severe on short wave-lengths than on long wave-lengths and at the very short wave-lengths used by the authors in the experiments herein described, little or no difficulty from this source was experienced. This freedom from static is due both to the short wave-length employed and the extremely small antenna necessary for reception.

Franklin, Marconi, and others have recently performed experiments with directional transmission and reception using wave-lengths of 20 meters and less. At the Bureau of Standards the authors recently conducted a similar series of experiments using a wave-length of 10 meters. It is the purpose of this article to describe the apparatus used in these experiments and to present the results obtained. The generation and directive radiation of waves of the order of 10 meters resolves itself into (1) the development of a 10-meter electron-tube generator (of suitable power), (2) the development of an efficient directive reflecting system for radio waves of this wave-length, and (3) the development of a 10-meter receiving apparatus.

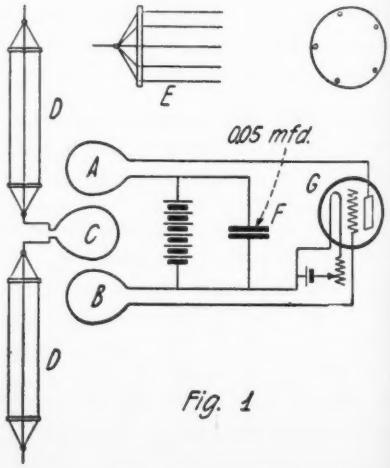
Before an attempt was made to develop a directive type of antenna for waves of the order of 10 meters in length it was necessary to develop an electron tube generator capable of producing waves of this length. This was no small task with the restriction that only certain types of power tubes were available and these not designed to operate at such high frequencies. A 50-watt tube of the coated filament type was found, however, which could be operated on a wave-length as low as 10 meters. Several circuits and arrangements of plate and grid coils were used before oscillations at this frequency were obtained.

The circuit which was found to operate satisfactorily is shown in Fig. 1. Coil A consists of a single turn 17 cm. in diameter for plate coupling, and coil B is a similar coil for grid coupling. The capacity between the elements of the tube, together with these coils, forms the oscillatory circuit. It is this internal capacity which determines the upper limit of the frequencies obtainable with a given tube.

This short wave generator was coupled to the radiating system (the antenna) D by means of a single turn coil C as shown in Fig. 1. The antenna was made up of two sets of vertical wires as shown at E, Fig. 1. Each set of wires was 1.8 meters long. Adjacent wires were spaced 3 cms. apart.

The arrangement of the antenna with respect to the coils and tube is shown in Fig. 2. It will be noted that all leads were made as short as possible. The glass antenna insulators may be seen above and below the frame holding the generating set.

A system of Lecher wires was used for measuring the wave-length of this short wave generator. Fig. 3 shows a wave meter for measuring wave-lengths of the order of 10 meters. It is noteworthy that the range of this wave meter is one meter, as contrasted with the usual type of wave meter



Circuit of a Ten-Meter Generating Set. Detail of the Aerial is Shown at E.

*Published by permission of the Director of the Bureau of Standards.

having a wave-length range of 200 or 300 meters.

A method of generating wave-lengths of the order of 10 meters having been found, the next step was to develop a reflecting system so that the radiated power could be transmitted in one direction. There are several methods of obtaining semi-directive transmission, such as by the use of a coil antenna, a long low antenna, etc., but the most efficient method is by the use of short wave-lengths and a reflector of the parabolic type. The wave from this type of reflector is *uni directional,* being similar to a parallel beam of light which has passed through a slit in an opaque screen.

Fig. 4 illustrates the reflector of the parabolic type as constructed. It is in the shape of a segment of a parabolic cylinder and is made by suspending 40 wires from a frame constructed in the form of a parabola. Each of these wires is tuned to 10 meters and they are spaced 30.47 cm. (1 foot) apart. The frame is suspended from a rope stretched between two poles, so that the reflector may be rotated through 360°. The suspended wires are insulated from the frame and from each other, by means of small glass insulators. The focal distance was made one-quarter of a wave-length; that is, 2.5 m. (8 feet 2.4 inches). With this distance determined, the parabolic frame may be constructed. It is important to have a frame of this shape in order to maintain the proper phase relations and to obtain maximum reflection. The 10-meter generating set with antenna is shown suspended at the focus (in the center). The power radiated from this antenna goes out in the direction of the opening of the parabolic cylinder part of which is reflected from the 40 suspended wires.

The receiving apparatus used for reception at these very short wave-lengths is shown in Figs. 5, 6 and 7. Fig. 6 shows the type of coil antenna used for making measurements of the radiated energy about the reflector. Tuning was accomplished by means of a two plate variable condenser and resonance was indicated by means of a galvanometer and thermo-couple. With a single turn coil of this type and only six inches in diameter, strong signals were received from the Bureau of Standards at a point about two miles away. A detector and two stages of audio frequency amplification were used in this reception.

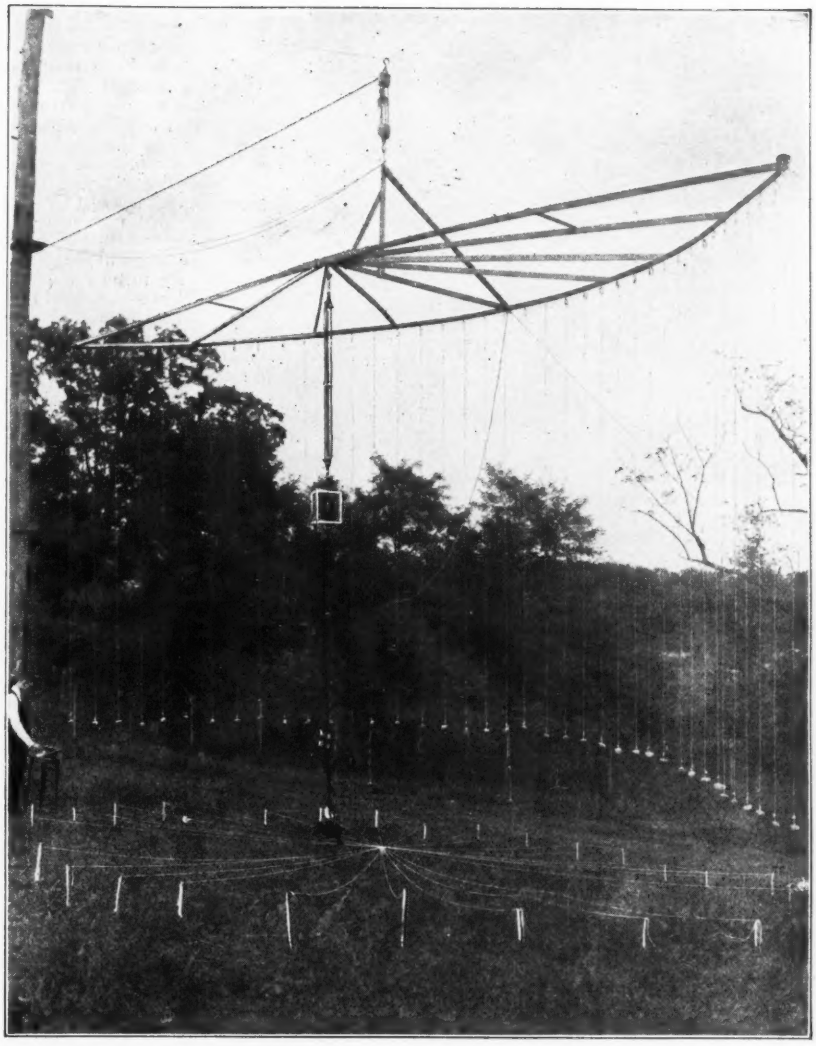
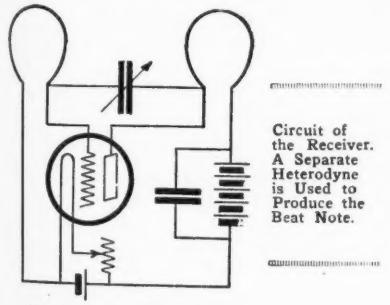


Fig. 4. The Parabolic Reflector at the Transmitting Station. Note the Oscillator in the Box Between the Two Small Cage Aerials Acting as Aerial and Counterpoise.



Circuit of the Receiver. A Separate Heterodyne is Used to Produce the Beat Note.

Heterodyne

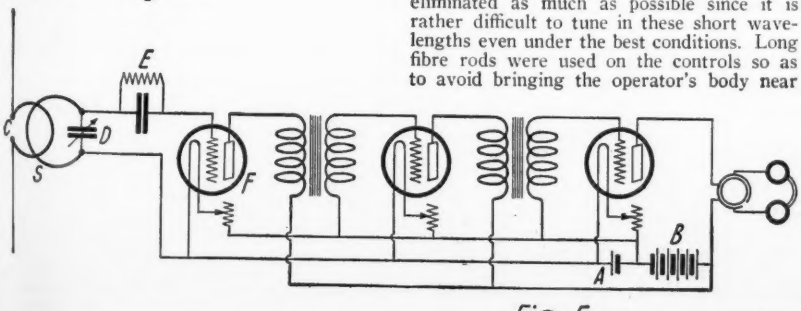


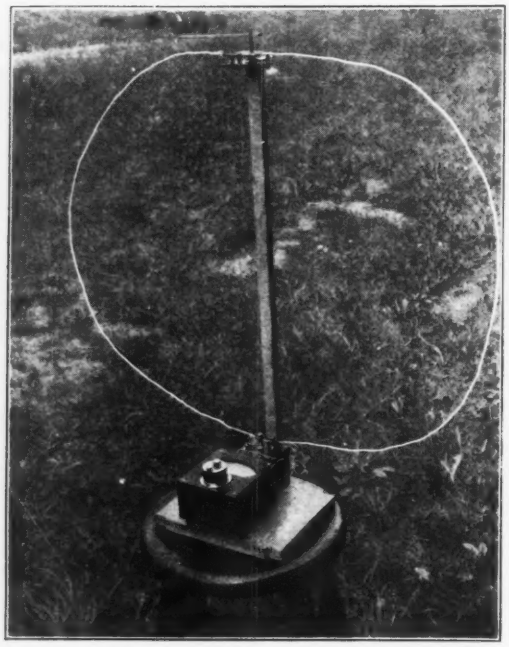
Fig. 5

For receiving signals at greater distances a receiving set consisting of a detector and two stages of audio frequency amplification was used. An external heterodyne was used when receiving continuous wave signals. This is shown in Figs. 5 and 7. Ordinary receiving tubes were used in this set and usual connections employed. The secondary coil "S" of the receiving set (Fig. 5) consisted of one turn of wire and was about twelve inches in diameter. The antenna "C" was made of about fourteen feet six inches of number 12 wire and was suspended on a wooden frame with the coupling coil of the receiving set at the center point.

In constructing a set of this kind it is very important that stray capacities be eliminated as much as possible since it is rather difficult to tune in these short wave-lengths even under the best conditions. Long fibre rods were used on the controls so as to avoid bringing the operator's body near the apparatus. The detector tube was mounted directly on the antenna support in order to reduce the length of the grid lead to a minimum. The two stage audio frequency amplifier remained on the ground as shown in Fig. 7.

The receiving apparatus described gave very satisfactory results during the tests. Had it been necessary to cover greater distances, it is possible that more refined apparatus, such as the super heterodyne would have allowed reception over considerably greater distances. The addition of a parabolic reflector at the receiving station would also have greatly increased the distance over which the transmitted signals could have been received.

A method of directive transmission and means for reception having been obtained, a series of tests were made to study the nature of the transmission from such a system. For the purpose of making this study the reflector with generator and antenna was rotated, the receiving set remaining stationary about 170 feet from the reflector. The receiving set shown in Fig. 6 was used. As the reflector was rotated, through 360 degrees the galvanometer deflections produced at the receiving set were read for every 10 degree position of the reflector. As the reflector was pointed toward the receiving set, the deflections were a maximum and when it pointed in the opposite direction a minimum deflection was obtained. The results of this study are shown in Figs. 8 to 12.



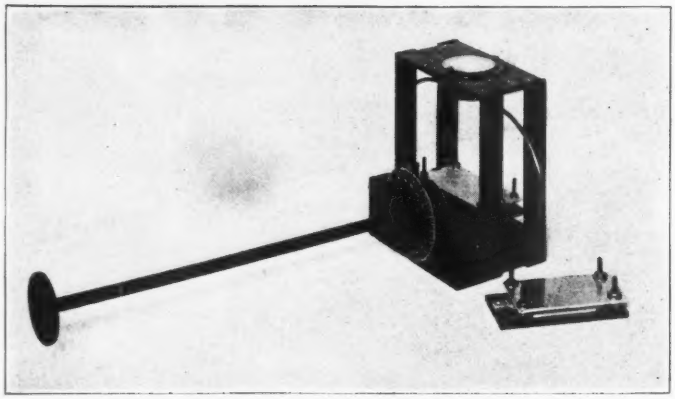


Fig. 6. Above: Receiving Apparatus for Studying Directive Characteristics of Radiation From a Parabolic Reflector. Fig. 3. A 10-Meter Wavemeter. This has a Range of One Meter.

Considerable experimenting was done to obtain the optimum length of the forty reflecting wires. The best results were obtained when the wires were exactly 4.39 meters (14 ft. 5 in.) long. Fig. 8 shows the data taken as mentioned above in polar curve form with this adjustment of the reflecting wires. It will be noted that the radiated power is practically all confined to an angle of 40 or 50 degrees. By turning the reflector 25 degrees off from the position of maximum reception the receiving galvanometer deflection decreased 50 per cent.

Fig. 9 shows the effect of slightly altering the wave-length of the 10 meter generating set at the focus of the parabola. It will be noted that such a change destroys the directive properties completely causing considerable leakage through the rear as shown by the shaded portion.

The aperture (opening) of the reflector was changed from one wave-length (10 meters) to 1.5 wave-lengths. This was done by adding 10 tuned wires one foot apart on each end of the parabolic frame which had been extended for this purpose. Fig. 10 indicates the results obtained. It will be seen that there is practically no leakage in the rear of the reflector and that the reflected wave is in a slightly narrower beam than was obtained in Fig. 8.

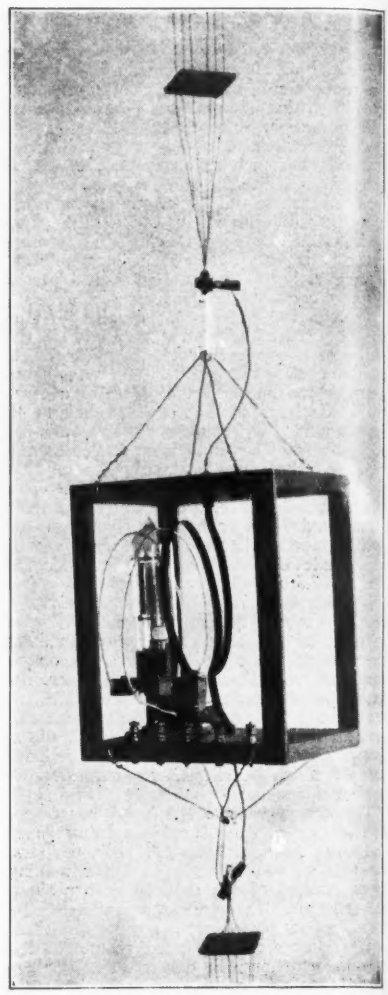


Fig. 3. Assembled 10-Meter Generating Set, Showing Method of Coupling to Antenna.

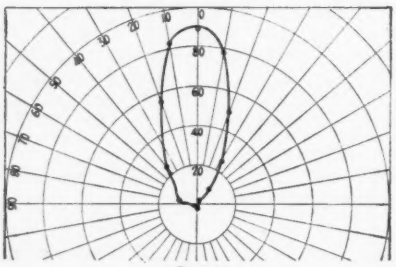


Fig. 10

Radiation Characteristic Curve of Parabolic Reflector. Aperture = 1.5 Wave-Length. $\lambda = 10$ Meters. Showing Effect of Increasing the Aperture from 1 to 1.5 Wave-Length.

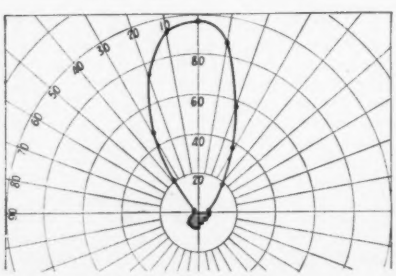


Fig. 11

Radiation Characteristic Curve of Parabolic Reflector. $\lambda = 10$ Meters. Aperture = One Wave-Length. Showing Effect of Using 20 Tuned Reflecting Wires.

Fig. 11 shows the results obtained when every other reflecting wire was removed leaving twenty wires instead of forty. It was found necessary to retune the twenty-wires due to the change in capacity effect caused by the removal of neighboring wires. Note that an increase in the number of reflecting wires improves the directive properties.

The effect of making a large opening in the rear of the reflector by taking out ten wires in the center of it is shown in Fig. 12. Note that the directive effect is greatly reduced and the leakage through the rear is considerable.

It will be seen from these curves that the narrower the beam is made the greater the received current. In fact, with no reflector at all the deflection of the receiving galvonometer was zero as against one hundred in the case of good directive transmission.

Absorption of the transmitted energy at this wave-length is very noticeable and was demonstrated by carrying the apparatus shown in Fig. 6 into a large building of steel

(*Continued on page* 182)

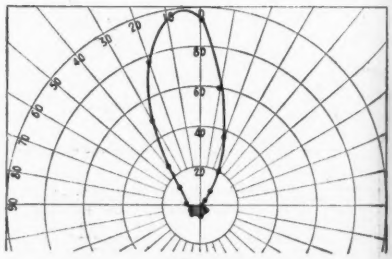


Fig. 8

Radiation Characteristic Curve of Parabolic Reflector. Aperture One Wave-Length. Showing Effects When Reflecting Wires Are in Tune with the Source.

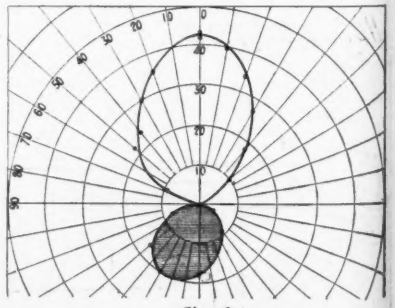


Fig. 9

Radiation Characteristic Curve of Parabolic Reflector $\lambda = 10$ Meters. Aperture = One Wave-Length. Showing Effect of Changing the Wave-Length of the Source.

Page the Amateurs

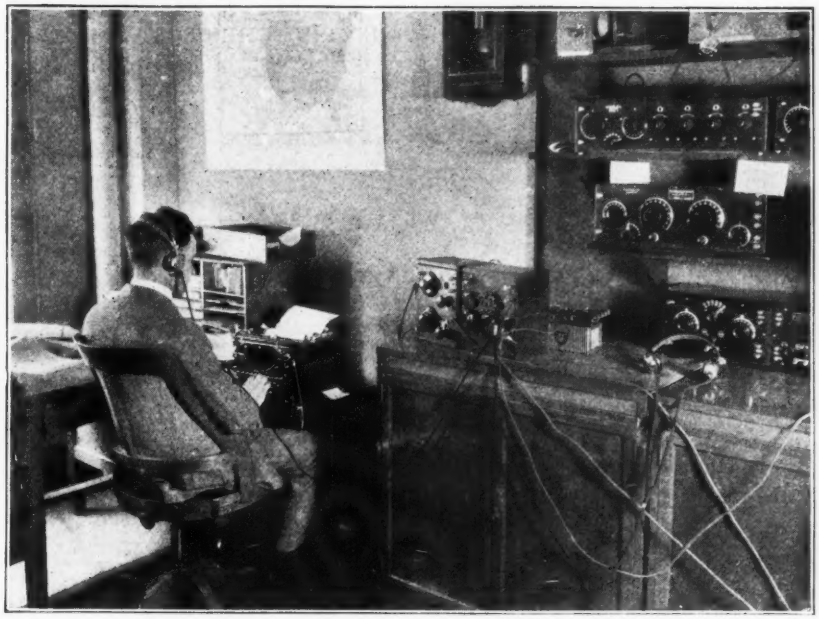
By J. FARRELL

LAST March a devastating spring frost hit the Southern fruit crops. Overnight the peach crop was damaged more than 25 per cent. Other early crops, including strawberries, potatoes and green goods, were proportionately damaged. The farmers of the country wanted quick information on the extent of the loss. Radio was rushed into the service, and information that had formerly taken several days to gather was compiled literally overnight.

"Use of radio in a crop crisis such as this has tremendous value," says W. F. Callander, Chief of the Crop and Livestock Statistics Division of the United States Department of Agriculture. "When frost, drought or storm causes sudden havoc to growing crops, we want the statistics quickly so that immediate action may be taken to repair the loss. The mails and telegraph are too slow. Apparently only radio will do."

Thus epitomized, the live-wire character of an arm of Government that proposes to use aeroplanes in estimating the size and condition of crops, and radio to spread the news quickly over the country is indicated. Yesterday and its methods are discarded for the revolutionizing changes of today.

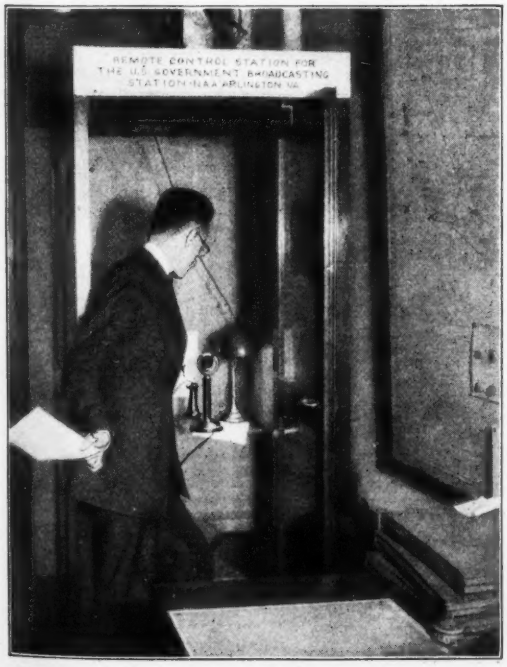
When the freeze warnings were issued by the weather forecasters last March, the Georgia field representative of the Crop Division immediately broadcast by radio a request for specific information of the extent of the damage. Reports were flashed back from all over the peach belt and the following morning the crop statistician had before him the most comprehensive survey of the situation ever compiled. A brief summary was flashed to Washington. The information was then broadcast from Arlington and relayed to the 90 or more stations handling market and crop news.



W. J. Holbrook, Radio Operator, at the U. S. Department of Agriculture, Records Crop and Market News Flashed by Broadcasting Stations Over the Country.

VOLUNTEER REPORTS

As a regular part of its duties this work ties up directly with the activities of the Federal Board of Crop Estimates in preparing national forecasts and estimates of crops. More than 200,000 voluntary and paid crop reporters all over the country regularly report to the Board on acreage and condition of growing crops. The service was recently characterized by the International Institute of Agriculture at Rome as the most efficient anywhere in the world, but the Department of Agriculture is continually seeking its improvement. Every possible safeguard to prevent inaccuracies and to make the service mechanically perfect is being erected, and in doing so radio is destined to play an important part.



The Booth from Which the Reports Are Broadcast by Radiophone Through Station NAA.

Of the Crop Board's organization approximately 30,000 workers are township crop reporters, nearly all of whom are practical farmers, and who report monthly on the crops grown in their immediate territory. These reports are forwarded by mail and several days are required to receive and tabulate the information. To speed up the work it is proposed that each of these reporters get in touch with local amateur operators to flash the news by radio to a central receiving point where it would be summarized and rebroadcast to Washington, thus cutting off several days in transmission. At Washington only a small staff of radio receiving operators would be required.

In the issuance of final crop reports every possible precaution is taken to prevent the totals for any of the so-called speculative crops from becoming known to any individual prior to the date of release fixed in advance by the Secretary of Agriculture. Even the tabulators and computers who make up the totals do not know the states to which they pertain, and the final telegraphic reports and comments of the field agents relating to the speculative crops are kept locked in the office of the Secretary until crop reporting day, when they are turned over to the Crop Reporting Board. The entire Board is immediately locked in a room until the minute the report is issued, guards being stationed at the doors, and all telephones disconnected.

AMATEUR ASSISTANCE DESIRED

In substituting radio for the mail system the assistance of the amateurs is regarded as practically indispensable. With more than 20,000 amateur operators throughout the country little difficulty is seen in pressing a sufficient number into the service to make the plan feasible. A special code system of radio telegraphy would be used. A similar system would be followed by the county and state crop reporters located in every county in the United States, and by the several crop specialists who cover each of the various crops as a whole.

According to Mr. Callander the service has limitless possibilities. Overnight a storm or other paroxysm of nature may cut thousands of bushels from the wheat and corn crops, the fruit crops, an entire field of cut hay may be ruined, and thousands of bales of cotton may be damaged. The loss may occur on crop-reporting day while the Crop Board is in session behind locked doors and entirely cut off from the outside world. The crop report could not possibly take into consideration prevailing conditions and as a result the estimates are anti-dated. With radio bringing into the Board room quick advices of moving conditions, the report can be made representative of conditions at the moment it is released.

SPECIAL LIVE STOCK REPORTS BY RADIO

Other services being developed by the Crop Division, such as the issuance of special reports on the livestock situation in the Corn Belt and on the Western cattle and sheep ranches, may also utilize radio in collecting data. At present this information is developed by mail and telegraph and frequent delay in getting the news to the pro-

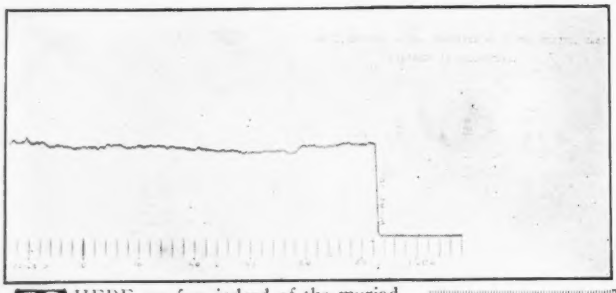
(Continued on page 184)

Recording Fading Signals

Some Interesting Experiments Carried Out With a Special Recording Apparatus Designed by

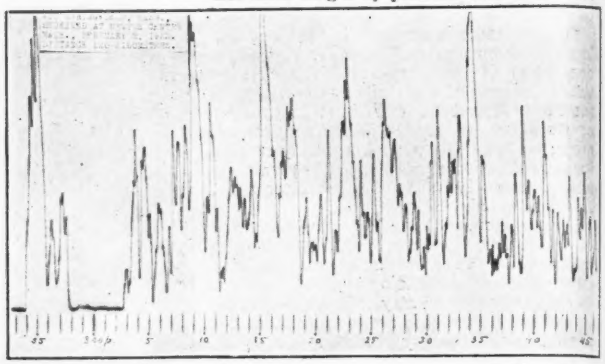
DR. G. W. PICKARD*

(INVENTOR OF THE CRYSTAL DETECTOR)



This Record Clearly Shows That For a Local Station There Are No Substantial Variations In Transmission.

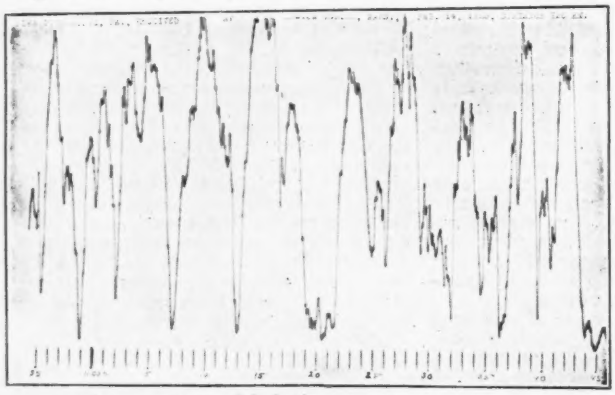
THERE are few indeed of the myriad broadcast listeners who have not noted large variations in the intensity of speech and music as received from all save nearby stations. On some evenings, particularly in winter, a very modest receiving equipment will pick up a score of stations, distant over a thousand miles, while on other nights stations outside of, say, a 50-mile radius are practically inaudible. But even on a good evening, nearly everyone has observed striking variations in intensity from minute to minute, and sometimes even from second to second. Unfortunately, a large number of listeners attribute these variations to changes in their receiving sets, and not only waste time twirling knobs in an attempt to restore the signal, but also fill their immediate neighborhood with squeals, which are indeed the only tangible result of their efforts. When the novice goes for an explanation of these happenings to his court of last resort—the radio editor of his daily paper—he is usually told that such variations are caused by "atmospheric conditions"; an answer which probably completely sums up our present day knowledge of this subject, and by its paucity urgently calls for further investigation.



The Period 7.58 to 8.03 P. M. On This Record Was An Intermission, In Which the Carrier Wave Was Cut Off. The Slight Waviness of the Line Indicates a Certain Small Amount of "Background" Disturbance; a Complex of Distant Spark and Broadcasting Stations, Static, Switching, etc.

FADING WAS EVER PRESENT

These variations in radio transmission are by no means peculiar to broadcasting, as they have been observed for some 20 years as a most baffling phase of radio telegraphic transmission. But with the advent of radiophone broadcasting, such observations have passed from a few hundred radio engineers and operators, to an audience of some million or more, and it is the purpose of this article not only to show this larger audience the reality of these effects, but also to enlist the coöperation of those who have the inclination to engage in some real radio research work. It is only by the accumulation of such data, gathered at many different points, that we may hope to find the true cause of these variations. The author has recently undertaken an investigation of this subject, and has furnished RADIO NEWS with some typical samples of his many photographic records, together with a schematic diagram of the simple apparatus required, in the hope that advanced amateurs and others will set up similar apparatus and conduct tests at their stations. Not only will this work be found intensely interesting, but those who undertake it can rest assured that their labors will materially assist in the solution of this long-standing problem.



This is a Very Pretty Example of Periodic Fading, the Intensity Dropping to Very Low Values, and Quickly Recovering, With a Marked Rhythm.

Note the Slow General Increase in Signal Strength From 10.25 to 11.13 P. M., With Short Period Variations Superposed.

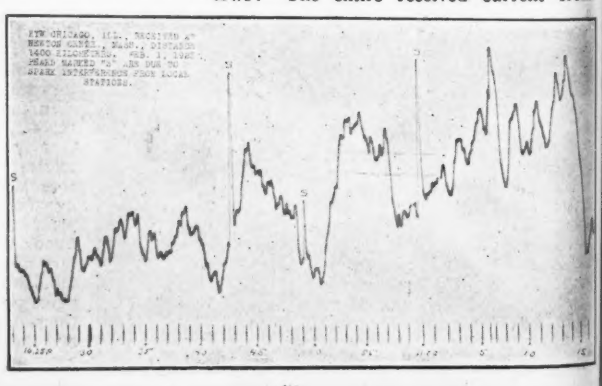
THE RECORDER

Fig. 1 is a diagram of the circuit and apparatus employed in receiving and recording the fluctuations in signal strength. The tuner is of the ordinary two-circuit variety, comprising primary and secondary coils L and L-1, respectively, the primary or antenna circuit being tuned by a variable air condenser in series, and the secondary by a shunt condenser of the same type. A loose coupling between the two circuits should be used, in order to eliminate as far as possible all disturbing signals, which would otherwise obscure the record. Four stages of radio frequency amplification are shown in the diagram, of the customary transformer coupled type, although for most cases one or two stages will be found sufficient, unless a very insensitive galvanometer is used. The grid bias of the first tube is controlled by potentiometer P-1, and the grids of the last three stages by potentiometer P-2. The plate and filament voltages are indicated on the diagram, and UV-201A tubes are used. It is only natural that a crystal detector is used as shown at D, for its merits as an efficient rectifier were long ago appreciated by Mr. Pickard, who invented the device. A tube rectifier is not satisfactory in this work, as its rectification is not rigorously constant, and the direct current in its output circuit does not as a rule become zero when the input ceases.

G is a galvanometer of the D'Arsonval type, with a mirror instead of a pointer, and is equipped with a shunt box to adjust its deflections to the limits of the record sheet width. The rectified current from detector D swings the galvanometer coil and attached mirror in exact proportion to its strength, from moment to moment, and a tiny pencil of light from a source L is reflected by the galvanometer mirror and focused as a pinhead spot on a revolving cylinder CYL. Around this cylinder is wrapped a sheet of sensitive photographic paper, and the cylinder is rotated once an hour by attachment to the minute hand shaft of a driving clock. TMS is the timemarker source, consisting of a small electric light and lens system, which is momentarily flashed on the lower margin of the record sheet at one-minute intervals. In this way time in minutes is registered in the form of short vertical lines, as shown at the bottom of each of the succeeding figures.

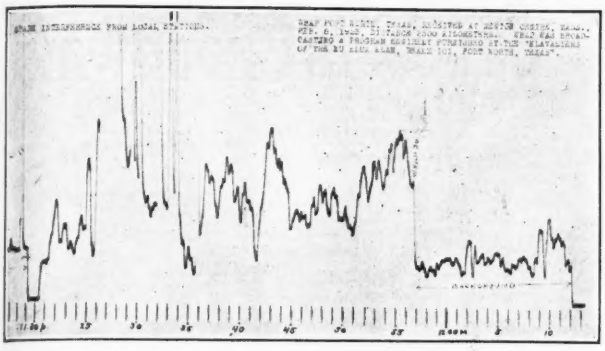
HOW THE RECORDER WORKS

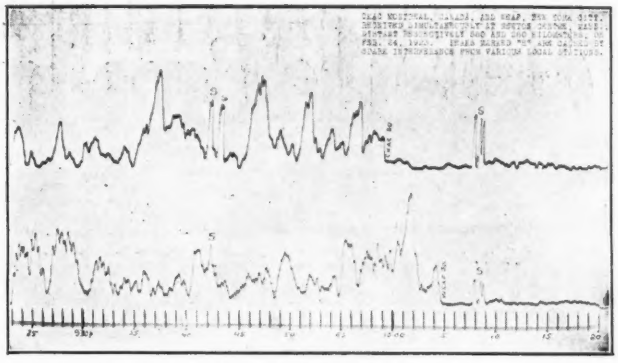
The operation of the apparatus is as follows: The entire received current from



*Consulting engineer of the Wireless Specialty Apparatus Co.

the distant station, including the carrier wave and its side bands due to modulation, is amplified at radio frequency and impressed upon the rectifier D. A direct current results, whose intensity is not at all dependent upon the modulation at the distant station, but only upon the total received energy. The beam of light, reflected from the galvanometer mirror, swings across the record sheet by an amount dependent upon the value of the detector current, and, in combination with the rotation of the cylinder, traces out a curve giving a continuous record of momentary intensities. It is of course necessary that the amplifier and detector should remain absolutely constant over the period of the record, and this is assured by maintaining the filament and plate voltages rigidly constant, and protecting the detector from any jar which would change its sensitiveness. In this connection it is interesting to note that a crystal detector preceded by a radio frequency amplifier is practically immune from electrical disturbances, which would change its adjustment if it were directly coupled to the receiving antenna. Finally, a monitoring telephone is connected in series with the galvanometer and detector, so that the circuits may be initially adjusted, the station identified, and disturbances logged, to later be entered upon the record itself.





In Making This Record Two Small, Well Separated Aerials Were Used, and, of Course, Two Separate Receiving Sets and Galvanometers. It Will Be Noted That In General the Transmissions From These Two Stations Do Not Vary Together. The Coincidences Between Peaks and Valleys in the Two Traces Are Few, and These Seem to be Purely Accidental. In the Record on the Left, a Very Noticeable Amount of Background Disturbance is Shown. The Station Signed Off at 11:57 P. M., But From That Time Until 12:12 A. M. a Varying Disturbance Is Recorded, Having Nearly Half the Intensity of the Station Itself. At 12:12 A. M. the Galvanometer Circuit Was Opened, and the Short Trace From 12:12 to 12:13 A. M. Gives the Zero Line For This Record.

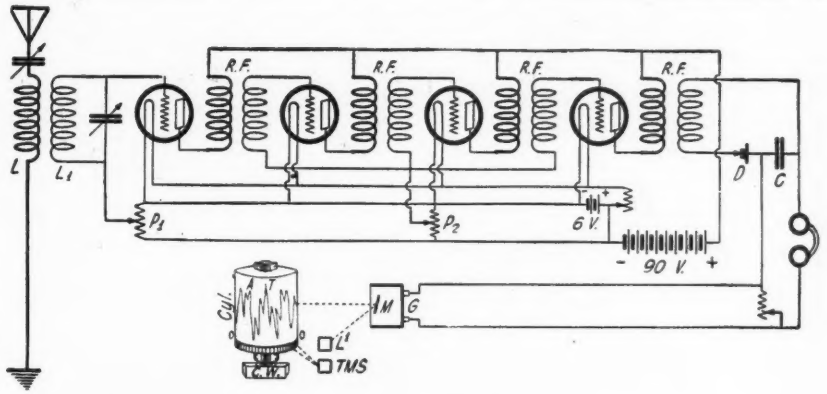
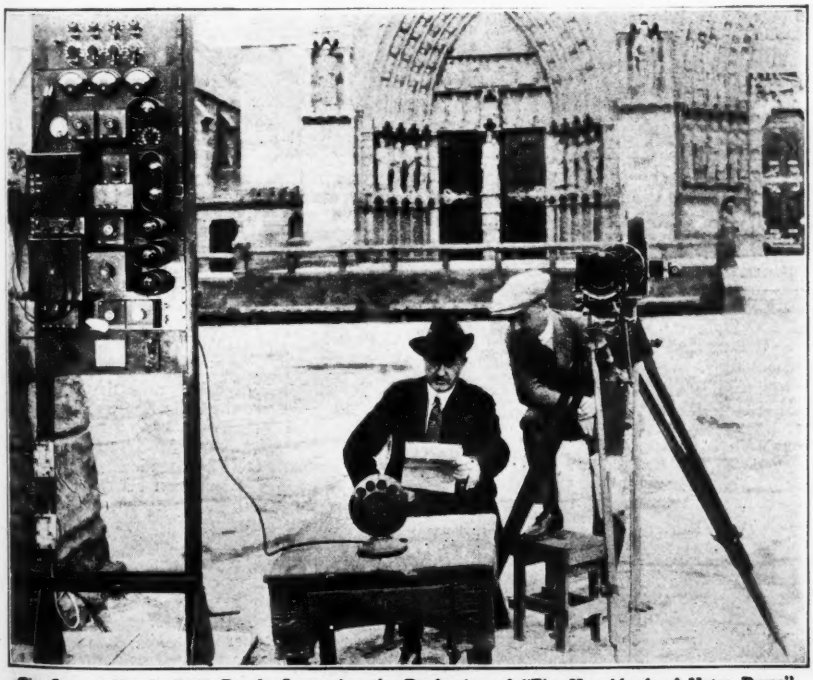


Fig. 1. A Diagram of the Circuit and Apparatus Employed in Receiving and Recording the Fluctuations in Signal Strength.

A New Use for Loud Speakers



The Cast of Nearly 5,000 People Composing the Production of "The Hunchback of Notre Dame" Was Perfectly Directed By Use of a Western Electric Public Address System.

HANDLING the vast crowds of a motion picture spectacle, involving the minute direction of thousands of "extras" in mob scenes, has been reduced from one of the gravest problems that confront the film producer to one of the simplest operations in his hectic calling. Electricity has smoothed his path toward realism, and the microphone and loud-speaking telephone, operated by power amplifiers, have cut away with one sweep the bonds that once held him to days of painstaking rehearsals, and disappointing fiascos that of yore cost thousands of feet of spoiled negatives.

The most perfect example of what amplifiers can do for the picture producer is seen in the production of "The Hunchback of Notre Dame," super-production being filmed at Universal City. Its cast of nearly five thousand people, working in a setting that covers more than nine acres, was perfectly directed by the most complete installation of its kind ever devised for such work.

The basis of the system is a Western Electric No. 2 Public Address system. To adapt it for use on a film set, various special features have been added to it.

Two boards control the apparatus. One, the power control, handles the current, generated by a motor generator installed in the building that houses the boards, and actuated from the 110-volt line current on the premises. The plate voltage is 350 and the filament 18.

(Continued on page 219)

How Bertha Brainard "Broadcasts Broadway"

By GOLDA M. GOLDMAN

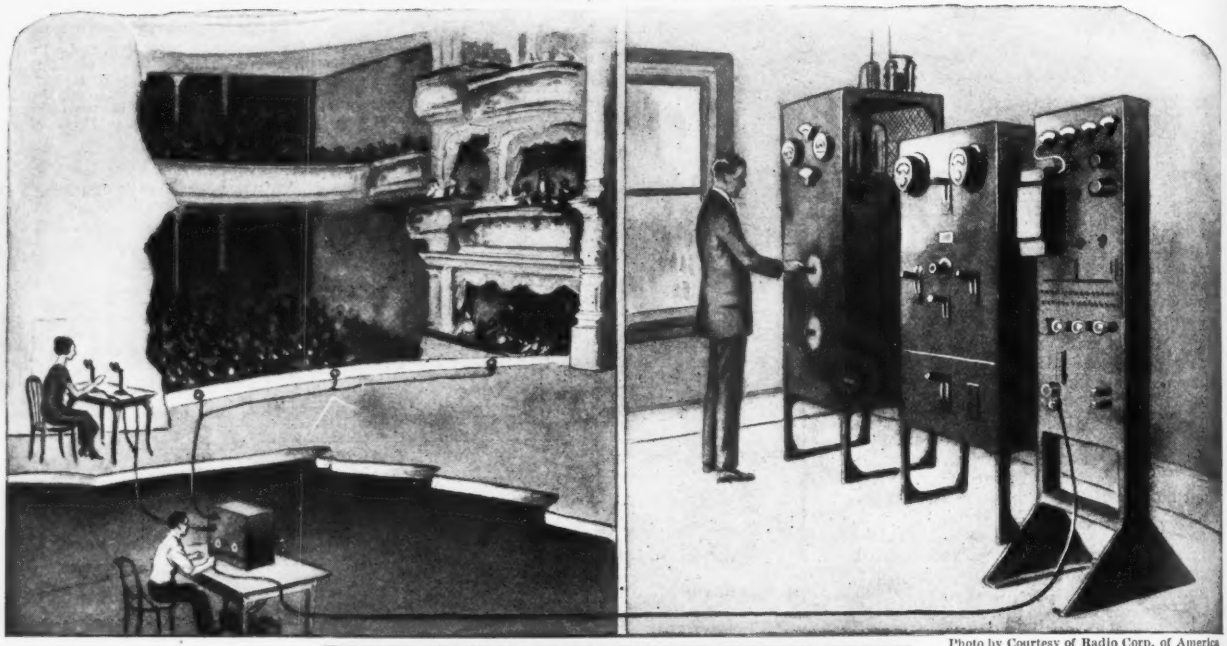


Photo by Courtesy of Radio Corp. of America

Above is Shown How a Play is Broadcast Directly from the Stage of a Theatre. A Telephone Line Connects the Theatre to the Station, an Amplifier Being Used Under the Stage to Boost Up the Music and Voice Before it is Relayed.

On the Left Miss Brainard is Seen Broadcasting "To the World," Which Conceals the Microphone of Station WJZ, the Last News of the Theatrical District of New York City.

"I WISH you could see this dance," says Miss Brainard as she talks to you from the wings of a theatre.

"I wish you could see Bertha Brainard as she 'Broadcasts Broadway'," is what I thought the first time I saw her in the old Westinghouse studio WJZ in Newark. She is, to be as alliterative as her name, a dainty, delightful, debonair little lady, who would make as charming a picture on the stage as do any of the popular favorites whose work she tells you about. Her hair is her crown of glory, and a very gleaming crown it is at that. She herself said of it once:

"When I want the people to remember me I take off my hat. When I don't care I keep it on!"

Since Miss Brainard's mind is as agile as is her small person as it flashes about the studio, she originated her own "stunt" over a year ago. It occurred to her that radio reaches vast audiences in out-of-town sections, who see, at the most, only one metropolitan newspaper each day, and in the majority of cases see none at all. These people find it exceedingly difficult to keep abreast of the modern dramatic movements, as such information as they can obtain is culled from the criticisms in the various periodicals. These in most instances are comparatively colorless recitals, lacking the flavor of personal contact with the people and affairs of the theatre.

To Miss Brainard came the idea of giving informal talks by radio on the interesting plays of the day. Mr. Poponoe, studio manager of WJZ, now the Broadcast Central of the Radio Corporation of America, agreed to this plan, and so for the first time Bertha Brainard "Broadcast Broadway."

The selection of plays for this feature is a very careful one, for so many youngsters listen-in that sex and problem plays in general, regardless of their individual merits, must be avoided. Comedies and musical shows predominate, and for each of these in her pleasant fashion Miss Brainard gives the name and producer of the play, the star

(Continued on page 226)

What Radio Can Do for the Country

By FLORENCE T. HARPER

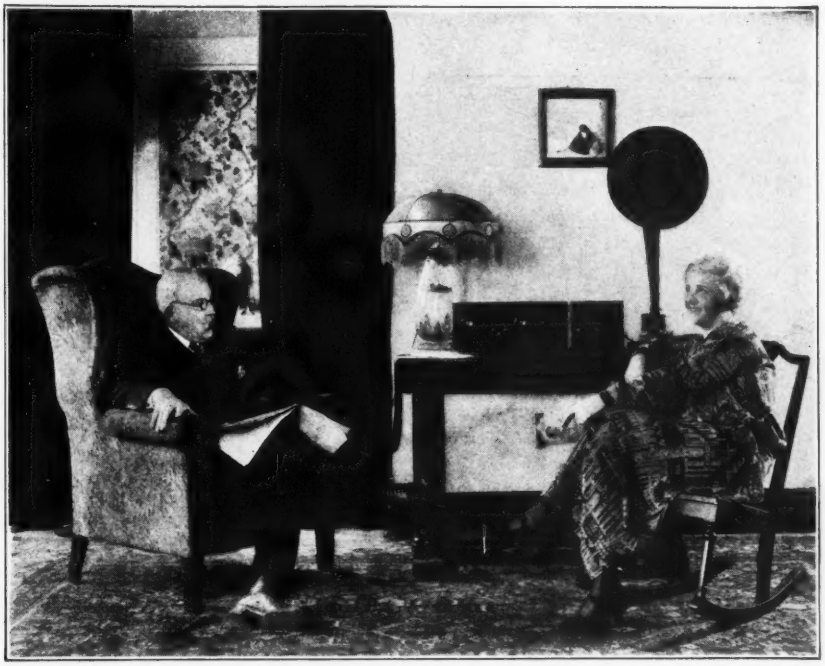
TO you lucky ones who possess radio sets, I just want to deliver a message of a little country town down in the South Central part of Pennsylvania that is representative of the many country districts throughout our land, even to the detail that its chief claim to recognition is the remembrance of a glorious past.

As country towns go, this one did not follow the prescribed formula of developing into a small industrial center. Whether it was because it was too far from the main railroad line, or because of its previous scholastic precepts, is hard to say, but it refused to change as time went on. And so, to a casual observer, things remained about the same, except that there developed a shrinking tendency both in its younger set and to some extent in the character of its remaining population.

Of course there were store keepers, doctors, lawyers and the like, but the majority were farmers. Spasmodic interest developed about the village post office when the morning mail arrived, after which there would be nothing further to look forward to until the evening train would return its cargo of a few extravagant friends who had the courage to journey to the nearest city on a shopping expedition. The housewife's duties went wearily on with accustomed regularity, and if by chance an hour or so of unoccupied time was discovered on one's hands, it was a terrible problem to devise a way to utilize it.

Sons and daughters, at an early age, conceived the idea that the best alternative for them was to get away to college or to the city as soon as they were out of school, for this environment offered a more proper sedative to their famished spirits.

So the elder folks found themselves quite alone to continue the duties of home and farm, and the many other occupations that fell to their lot, saying nothing of the dreary evenings they were compelled to spend alone with consequent ingrowing dispositions and a shrinking interest in most things worth while. They were out of touch with the rest of the busily interested world and their conversations usually turned to the small matter of personalities and noisy gossip as their chief diversions.



The Pleasure and Benefit Derived from Radio in the Homes of City Residents Are Indisputable. Radio is a Most Satisfactory Source of Diversion. The Tired Business-Man and Housewife Can Sit Back at Ease and Enjoy 57 Varieties of Amusement.

That poor little country town away off there in the rolling hills found itself lonely and neglected. Of course in the summer time it was somewhat better, not so lonely and confining. One could get out, go fishing, swimming, camping, picknicking and to the meeting house once a week, or the church socials and the movies. But in the winter time, it meant being shut in by the glistening snow drifts, and the crisp frosty nights, when a cold, steel-blue sky warns of the need of an extra armful of wood by the stove and the crunching footsteps in the snow outside tell the good wife that everything is being made snug for the night, even if the mercury does drop below zero. The family auto-mo-bile (Ford of course) that once went to New Yo-rk Ci-ty is safely tucked away in its winter covers, and jacked up high until the roads become passable again.

However, the City Dwellers Can Little Imagine the Enjoyment the People of the Country Derive from Radio. Far Away from all Activities, These Isolated People Hunger for Something to Break the Monotony of Their Existence. Radio is the Solution.

But to a youngster it is only six o'clock, and there are three hours of boredom ahead, with nothing to do but finger over the much read books or magazines, and maybe to be tortured a little with some very stale phonograph music. Sister Nan has exhausted her wits in contriving some novelty in the way of entertainment that would tempt her neighbors to face the cold and spend another sociable evening about the big open fire-place.

Time passes heavily on with almost maddening monotony. I have often wondered what the matter was. Now I know; we were out of touch with the rest of the world; out of step. You need someone bigger than you to give you new and better things to think about, good music, lectures, song and laughter and to keep in touch with the world in general.

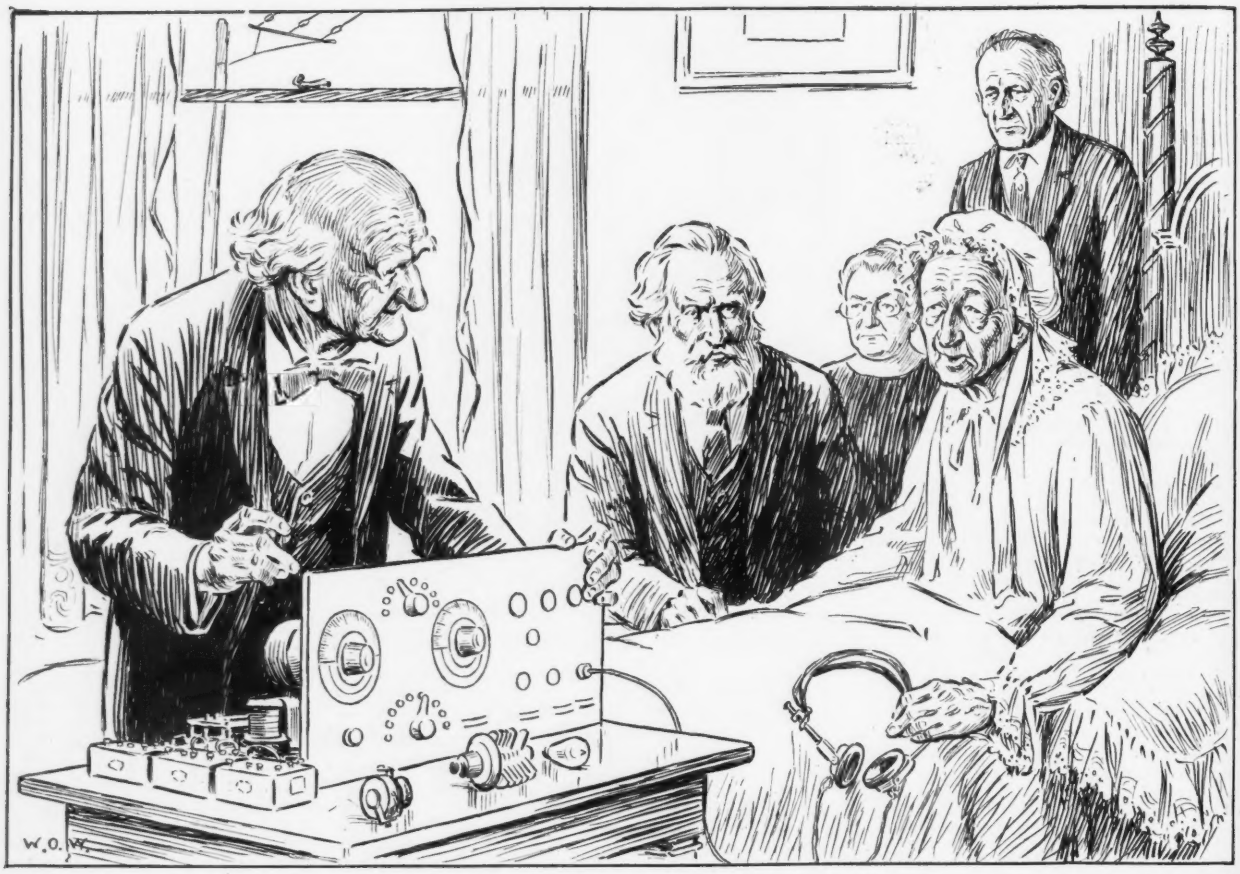
It is the divine urge in each and every one of us to improve our minds and to progress; nothing can stand still. If we do not go forward, then we go backwards, but the law demands that we "move." A strong desire for the enjoyment of new sensations comes along with education and knowledge. The saddest thing in the world is ignorance; it keeps us in the dark corners and our thoughts are of poverty, unhappiness and all that goes with negative thinking. But with the coming of the biggest discovery of the age, radio, come also light, knowledge,

(*Continued on page* 176)

Hetterby's Set

By ELLIS PARKER BUTLER

Author of "Pigs is Pigs"



With Trembling Fingers Old Jessica Felt On the Bed For the Ear-Phones; As Her Hands Touched Them She Stared At Her Aged Husband With Tear-Filled Eyes.

I REMEMBER, as well as if it were yesterday, the evening young Hetterby came laughing into my father's home, his young wife sort of urging him on, and how he apologized for coming to see us before we had made a formal call on them. I remember, too, how my father shook his hand and said, "That's all right! Come right in! Neighbors should be neighbors," and how my mother said to Mrs. Hetterby, "It's shameful, and that's a fact; we should have called on you long ago, but the truth is that Henry has been so interested in fixing up his radio set that we haven't gone anywhere. We're awful glad you've come!"

Then Mrs. Hetterby said, "Well, it's radio that's made us come, so that evens it up. I simply insisted that Sam come over and hear your radio and see how simple and easy it is to make one like yours—"

And that, you may be sure, set father going, and he led the way into that little back room he calls our "radio room," and in a minute he was explaining the set to Hetterby, and letting Hetterby and his wife hear Newark and Schenectady and Davenport and all those stations that were broadcasting back in those days. And Hetterby was interested, but nothing like as interested, it seemed to me, as Mrs. Hetterby was.

Mrs. Hetterby—Jessica was her name—was one of the dearest and sweetest and snappiest little wives I ever saw. She was a young darling, if ever there was one, and as happy as a wren, but, of course, she was alone a good deal of the time in our suburb of Westcote.

It wasn't so much that Sam, her husband, went to town every day, for nearly all the Westcote wives' husbands did that, but Westcote is an old and rather aristocratic suburb and a slow place for a newcomer to get acquainted in at any time, and doubly slow since radio came in and the wives hardly bother to go calling at all—just sit at home and listen to radio. So I dare say Jessica Hetterby, in her little new bungalow home next door to us, did feel that her days were rather long and empty, and that it would be pleasant to have a radio set of her own. And, of course, her husband was willing to give his darling young bride anything he could, so they came over to our house to see the radio set my father had made and was using. It was a case of make a set, with Hetterby, for they did not have much money to spare in those days.

So Hetterby looked at my father's set and asked a million and one questions about it, and it was amazing that anyone could ask so many questions about my father's set, for father was no mechanical sharp and his set was the simplest possible. He had it in an old cigar box and it always amazed those who saw it for the first time. There did not seem to be anything to it at all. There was some wire wrapped on some cardboard, and a crystal as big as the end of a lead pencil and not much else. There was room in the cigar box for three or four more sets of the same kind—it was simple, and that's the truth.

So dear little Jessica fairly danced on tiptoe as Sam asked questions and said, "Yes, I understand that!" and "Yes, I get that!" and "Yes, I see how that is." She said, "Oh, do you really think you can make one, Sam?"

"Sure! Easiest thing you know!" he said, and then he asked my father how long it took him to make the set.

"Two evenings, this one," my father said, "but I'm no mechanical genius. I'm a dub at this sort of thing. You ought to be able to make a set like this in one evening, easy, if you are any sort of a mechanical genius at all."

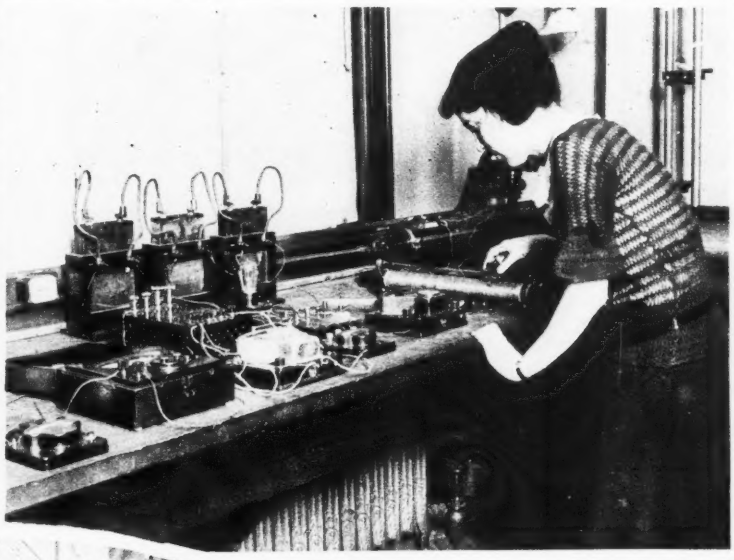
"And he is!" little Jessica cried, clapping her hands. She hopped right up on her tiptoes and threw her arms around Sam's neck and kissed him. "Oh!" she cried, "we may be able to hear Newark this very night before we go to bed!"

"Well, hardly that," my father said, "because Newark quits at 10:30"—which it did in those days—"but you may hear Ridgewood, if you can get an aerial up and your ground connection right."

"Well, we can! I just know we can!"

(*Continued on page* 222)

Radio Pictorial



Right: Photo Showing Miss Irene Bowman, Class of '23 at Barnard College, Studying the Operating Characteristics of Vacuum Tubes. Note the Layout of Apparatus Necessary For This Work.
(c) Kadel & Herbert

Below: "Make Your Boy a Radio Fan and Keep Him Off the Streets At Night." This is the Sage Advice of Mayor George E. Leach, of Minneapolis, Minn. He Is An Ardent Fan Himself. The Photo Shows Him Listening In At His Office In the City Hall. *© Fotogram, N. Y.*

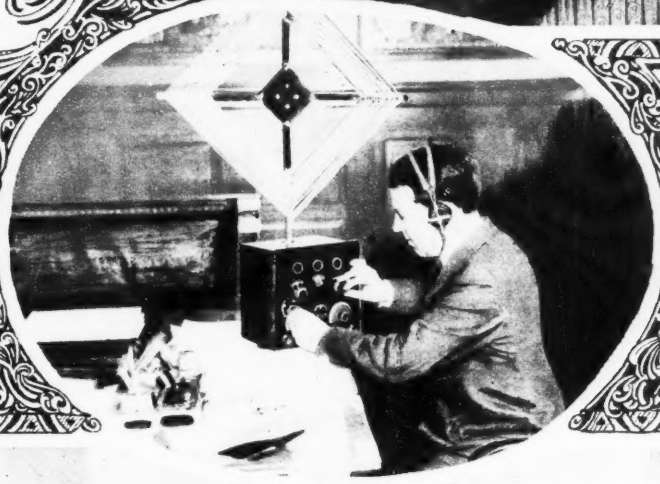
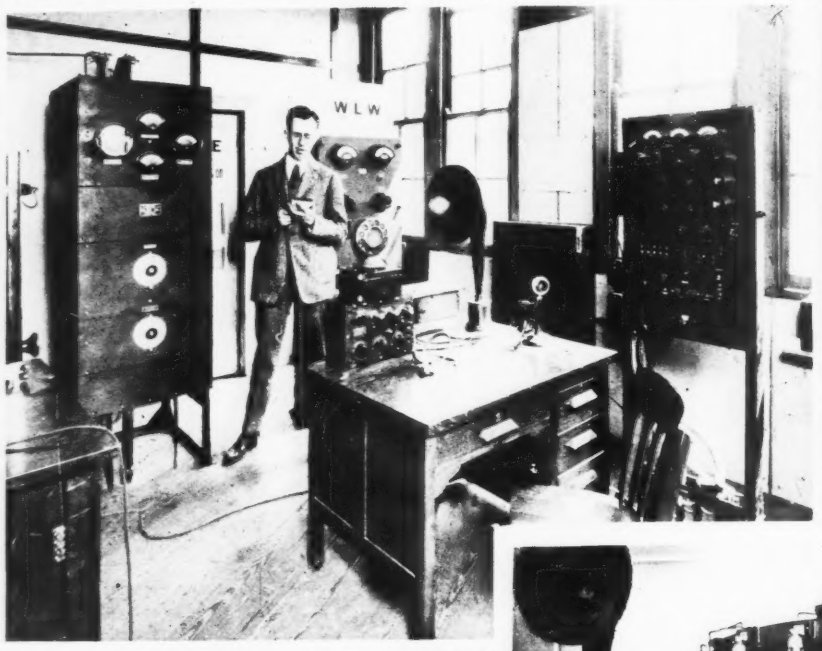
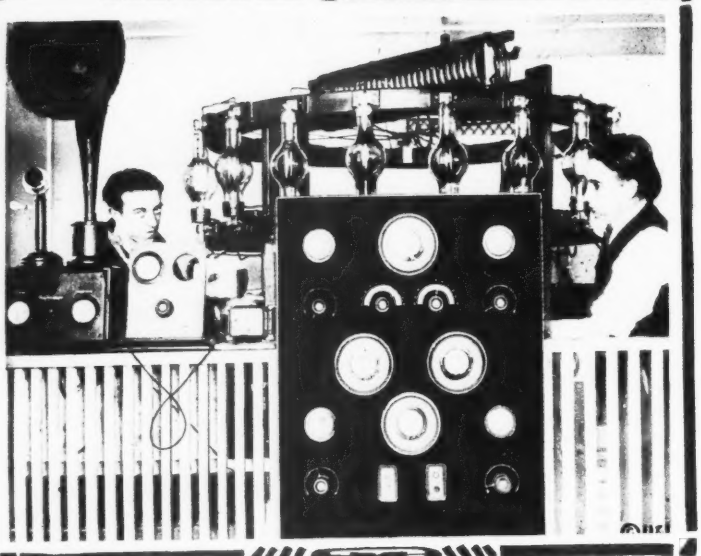


Photo Shows the Radio Apparatus In the Office of the Chief Radio Inspector At the U. S. Customs House, New York City. It Is Here That All Amateurs Must Take Examinations Before Receiving Their Licenses. At the Extreme Left of the Table Can Be Seen the Omnigraph Used For Examining the Applicants For Operatofs' Licenses.
© Photonews, N. Y.

Pictorial Review



Left: Powel Crosley, Jr., President of the Crosley Manufacturing Co., Dedicating the New 500-Watt Western Electric Radio Broadcasting Equipment At Station WLW, Cincinnati, Ohio. The Transmitting Unit Can Be Seen To the Left of Mr. Crosley, the Speech Amplifier Being to the Right of the Desk. A Complete Receiving Set and Power Amplifier Are Used When Checking Up On the Stations Transmitting. This Is Mounted on the Top of the Desk.



Giant Transmitter of the New Broadcasting Station WJAZ at the Edgewater Beach Hotel, Chicago. This Station Will Be the Most Powerful in the Country, With a 3,000-Mile Radius. The Big Tubes Are Arranged in a Complete Circle Surrounding the Set, So That the Wires Leading to Them Are All of the Same Length. The Studio, Located on the Ground Floor of the Hotel, is Walled With Plate Glass So That the Public Can See Just How the Broadcasting Is Carried On.
© U. & U.

Now That Summer Is Here and Old Man Static Is Getting Busy, the Loop Aerial Is Again Coming Into Its Own. Its Good Directional Qualities, and the Fact That It Reduces Static To a Minimum, Make It Highly Desirable For Summer Use or, in Fact, For Any Time. Wendall Kilmer, a New York Amateur, Mounts His Loop Aerial on the Wall and Turns It By Means Of An Old Automobile Steering Wheel.
© Kadel & Herbert

BRIDE WON BY RADIO

By ROSCOE SMITH

"Say it with flowers" is a sentimental phrase that may be popular in some quarters, but it no longer holds good with certain people. At least so says Jack Nelson, program director of Station WDAP, Drake Hotel and Board of Trade Broadcasting Station. Jack hit upon a new idea for conveying romance and it was none other than —hold your breath fans—"SAY IT WITH RADIO."

And Jack said it with radio quite a few times, early in April, broadcasting his sentiments to Miss Madelon Mooney in Toledo for several weeks until the last week in the month of showers, when they were married.

Of course Miss Mooney always listened in at Toledo, but she heard with greater significance the songs that the Northwestern University student was broadcasting, songs that he had written himself. And young Nelson, when he first conceived the idea of a radio courtship, was hampered by certain rules which forbid broadcasting anything save of general interest to the public.

# of Radio Events

Studio of Station WLW of the Crosley Manufacturing Co., Cincinnati, Ohio. From Left to Right In the Picture Are Fred Smith, Director at WLW, Jean T. Have, Violinist, Lucy de Young, Contralto, Mrs. Thomas Prewitt Williams, Accompanist, and Karl Kirksmith, First Cellist of the Cincinnati Symphony Orchestra. The Artists Are From the Artist Faculty of the Cincinnati Conservatory of Music.

©U.&U.

This Trio of New Yorkers Started From the City Hall, New York City, After Having Been Given An Official Send-Off By Mayor Hylan, On a Trip Around the World In Their "Radio Car," a Star Automobile, Especially Equipped With a Radio Receiving Set Furnished By A. H. Grebe & Co. From Left to Right Are Peter Taylor, Radio Expert, Blanding Sloan, Well-Known Scenic Artist, and Mildred Taylor, Writer.

© *U. & U.*

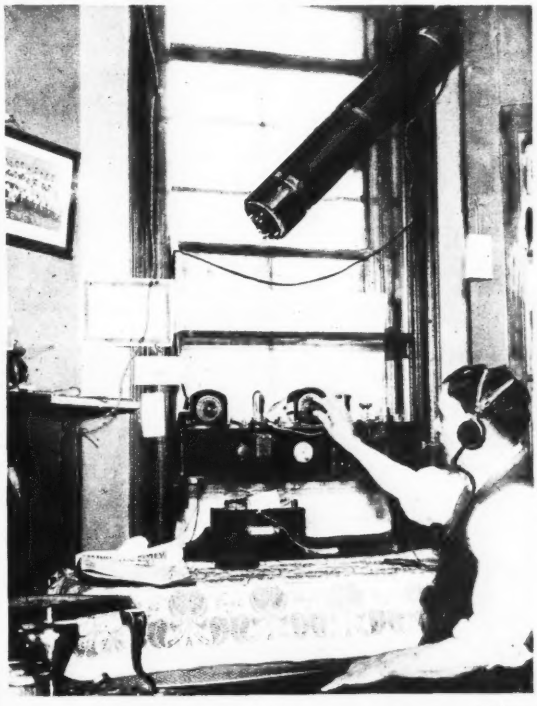


Photo Shows Edward Kelly, of New York City, Who Has Solved the Tenant Radio Problem By Doing Away With the Usual Outdoor Aerial. He Uses a Large Coil of Wire Wound On a Cardboard Tube, This Acting As a Wave Antenna. Mr. Kelly Has Succeeded In Bringing In a Number of DX Stations As Loud As the Local Ones. His Set is of the Single-Circuit Type Employing a Dry-Cell Tube. The Round Box on the Right of the Window Is His Substitute For An Aerial.

© *Photonews, N. Y.*

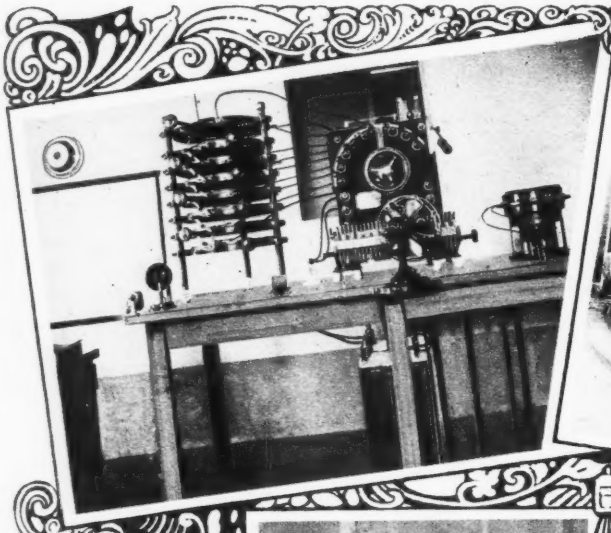
Just how it was done has been suggested by the announcements the program chairman put out before the songs were begun. In a code known only to themselves the two radio lovers readily interpreted such meaning phrases as "I love you," "Received your wire," and "Waiting for your letter," and a lot of other things. There could be no mistake, because Jack Nelson is one of Chicago's most versatile song writers and a playwright.

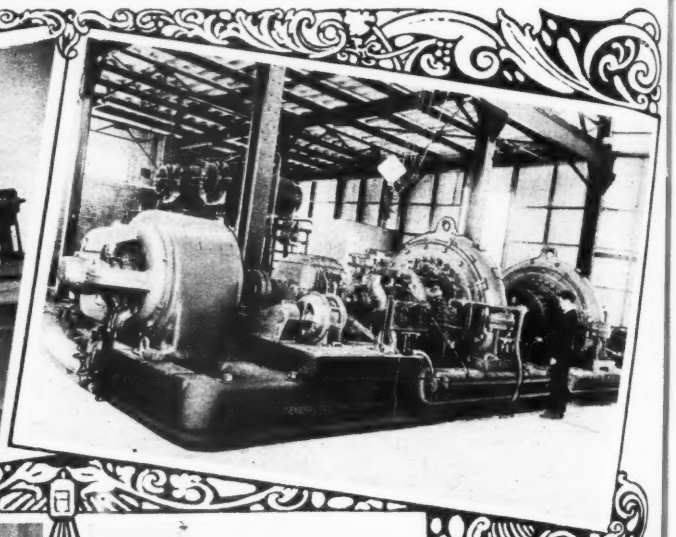
Anyhow, Jack tells the world he is happy and with his bride, now generally termed the "radio bride," is living happily right in the palatial Drake Hotel, close to Jack's work in one of the world's modern broadcasting stations.

Nelson wrote five musical comedies while he was a student at Northwestern, all of which were presented in Chicago theaters. He is the composer of the famous "WDAP Song," just had two songs placed with New York publishers, and has collaborated with Gus Kahn, composer of "My Buddy, "Carolina in the Morning," and also with Harry Akst, composer of "Dearest," and other song hits.

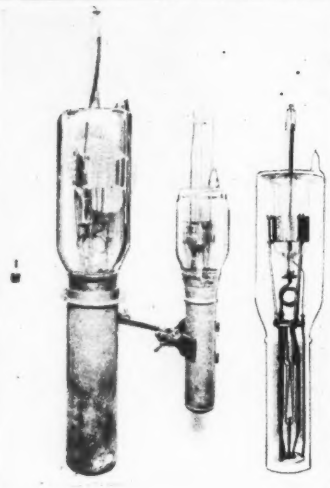
Recent Developments In Radio

By H. GERNSBACK
Member American Physical Society





Great Strides Have Been Taken, Particularly in the Design of Vacuum Tubes. The Board Held by the Man Includes, First, the Fleming Two-Element Vacuum Tube Followed by a Three-Element Audiotron, a Radiotron and, Finally, One of the Latest Types of "Peanut Tubes." Further On We Have Three Large Transmitting Tubes of the Type Used Today. The First One Is Of One Hundred Kilowatts Capacity and Two of These Can Do the Same Amount of Work as the Giant Alternator Pictured Directly Above. Note Its Size In Comparison With the Peanut Tube In the Same Photo



Above, and to the Left, Is a Photo of a Complete 2 K.W. Quenched Spark Transmitter of the Type Used by the Navy. These Are Slowly Giving Way to the More Efficient Vacuum Tube Transmitters. Directly Above is a Photo of the Interior of One of the High-Powered Trans-Atlantic Stations. The Picture Shows mainly the Huge High-Frequency Alternators. These, As Well, Are Being Scrapped To Be Replaced by the Vacuum Tube.

WHEN the average man or woman hears the word "Radio" nowadays, he or she immediately thinks of the radio telephone and its recent phenomenal development. Many laymen are still under the impression that the radiophone is a brand new invention, which has only just been developed in 1921. The average layman also has an idea that the radio telephone and the radio telegraph are entirely different things, and have nothing in common.

In the first place, the radio telephone is not a new development. It was first invented by Valdemar Poulsen, the Danish Edison, over fifteen years ago. Later, the American, Dr. Reginald A. Fessenden, also produced a radio telephone of his own, taking out many patents in connection with it. Even in 1915, the radio telephone had been developed to such an extent that words spoken at Arlington, Va., at Eiffel Tower station, Paris, France, and Honolulu, Hawaii, were distinctly heard. Any one who had the proper receiving instruments at that time, or even in Poulsen's time, could have listened in and heard what was going on, even at that early stage of the radio telephone.

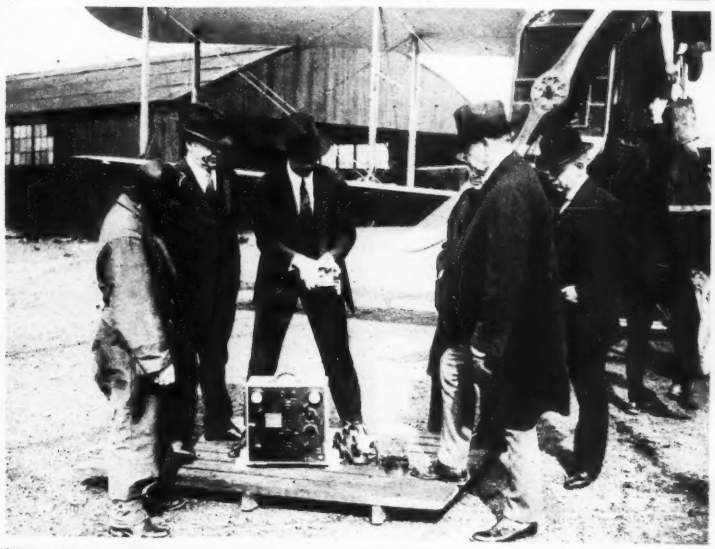
Broadcasting in scheduled programs, as we understand it today, however, has come into use extensively only since about 1921, and from that time on the public at large became interested. It should be noted, however, that the radio telephone and the radio telegraph are of the same family, just as the wire telephone and the wire telegraph work along similar principles. Indeed, the similarity of the radio telegraph and radio telephone is greater than that of their wire cousins. The radio telephone and the radio telegraph both make use of invisible waves set up in space; these are very similar to sound waves, which we all know. Sound waves and radio waves are fundamentally the same, except that the length of the waves varies. Radio waves are rather short, whereas sound waves are much longer. The longer the wave for a given power, the easier it is for it to cover greater distances. If you drop a small pebble into a pond, this will give rise to small waves. These do not travel very far. If, however, you look at one of the great swells in the ocean, you can realize why such a wave, being much longer, will naturally cover a greater distance. So much for the wave part.

Coming back to the radiophone, in which there is so much interest centered at the present time, we might state that at this time of writing there are over 600 broadcasting stations sending out regular schedules, in the United States. These stations vary from those of great power to the ones of small power, and nearly every large city in the United States today has one or more broadcasting stations. Great centers, such as, for instance, New York, Chicago, or San Francisco, have a great many stations, thus for instance, Los Angeles, has no less than 19 broadcasting stations. All of these operate on either a 360- or 400-meter wave-length at present, and if you have a good long distance vacuum tube receiver (and know how to tune it well) you can enjoy yourself every night by picking from the air dozens of stations scattered all over the country, bringing to your ears lectures, opera, jazz, songs, weather reports, market reports, and what not. The daily papers are publishing the programs of nearby stations, and a good vacuum tube receiver has no trouble in bringing in all of these stations, so that you can hear them over the whole house.

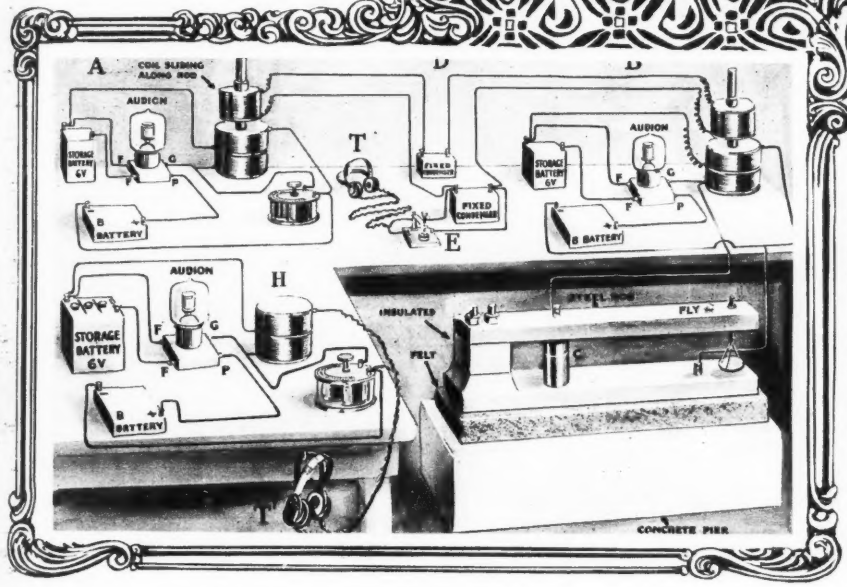
There is hardly a residence today in our large cities that does not have its radio outfit—good, bad, or indifferent, and the time is at hand when a house without its

radiophone will be a curiosity, just as is the home without its piano or phonograph today.

There is no question that, as far as broadcasting is concerned, the United States leads the world today. In England, for instance, the radiophone craze has just begun, but there is still chaos over there, and stations are only now beginning to work. In England, moreover, all broadcasting stations are more or less Government-controlled, and each receiving outfit must be licensed, a thing not known in the United States, where every one may stick up a wire on his roof and receive to his heart's content without paying a nickel for the service. In France there are only a few radiophone broadcasting stations, the Eiffel Tower being the most powerful one, but Argentina and Japan are of interest, where there are stations now being erected that will broadcast, and a few that are already operating. In all other countries, the effort so far has been rather feeble, but there is no question but that during the next few years radio broadcasting stations will dot the entire world, and it will be possible for a man to tune in to



Apparatus Capable of Measuring Two-Millionths Of An Inch. Queer As It May Seem, a Fly Walking On the Long Bar Will Bend It Sufficiently To Register In the Apparatus. The Vacuum Tube Is Responsible For This.



Compact Type of Vacuum Tube Transmitter Used On Aeroplanes. Power For the Tubes Is Derived From a Propeller-Driven Generator. This Is Another Case In Which the Vacuum Tube Plays An Important Part.

Copenhagen or to Cape Town in South Africa, if he is so inclined.

But what is behind all of this wonderful development? What developments were necessary to bring the present-day radiophone to the commanding position it now holds?

The art of radio today is a great Science by itself, and becomes greater and more powerful each and every day. Its ramifications are of such a nature as to astonish the layman who has not paid much attention to this young giant. As a matter of fact, the really big inventions in radio are hardly ever heard of by the public. But these inventions, bordering on the magical, should be known better by the "man in the street," as they will mean much to his every day life during the next decade.

We are all familiar with Marconi's original "thunder factory," where an operator pressed a key and a vivid, blue-white crashing spark was sent over a metallic gap with a thunder-like noise. This was in the days when radio was young, but even now, when you remember these blue sparks, it suddenly comes to you that it is rather seldom that you see them. Just the same, you know that the radio traffic, be it telegraph or telephone, goes on. But where is the spark?

It was soon found, after Marconi produced this spark, which produced the waves that were shot out into space, that these methods were wasteful. Only a small percentage of the energy was radiated by the aerial wires. The rest went up in heat. After the spark had been in use for some years, a German invented a sort of noiseless spark, technically called a "quenched spark." Here the spark leaped between metallic discs, separated from each other a few hundredths of an inch. Unless you put your ear close to such a quenched spark gap, as it is technically called, you could no longer hear the noise. Not only was the noise done away with, but the efficiency of the apparatus was increased a good deal.

After the quenched spark, came the Goldsmith and Alexanderson Alternators, machines that sent out the waves without any spark at all. This was another great improvement, and a great deal of energy was saved in the process. Still, with these generators, it was necessary to use large machinery in order to operate them, as they were nothing less than dynamos, in disguise.

So radio matters stood until about 1907, when a revolution in radio occurred. This revolution was due to a little glass bottle, invented by the American, Dr. de Forest, and called the Audion, or, as it is termed today, the Vacuum Tube. This little tube wrought havoc with all pre-conceived notions in radio and, as a matter of fact, threw the entire industry into an upheaval, which, however, was most beneficial. Years before Dr. de Forest, when as a matter of fact he was still wearing short pants, Edison had discovered the so-called "Edison Effect." The Edison Effect was demonstrated with two incandescent lamps in one; in other words, an electric lamp bulb having two filaments that did not touch anywhere, instead of a single filament.

Edison observed the curious fact that when these filaments were lit up by separate batteries, a current could be made to pass from one filament to the other, although they were not physically connected, but, on the contrary, were enclosed in a glass bulb which contained no air; a vacuum, in other words. Dr. de Forest made use of this principle with some modifications, and also enclosed in the tube still a third element, a piece of wire bent to and fro, which he termed the "Grid," due to its resemblance to its kitchen-utensil namesake. It was immediately found that such a tube, properly made, became tremendously sensitive to radio waves—so much so, in fact, that where heretofore we were using thousands of horsepower to bridge a given space with radio waves, only a fraction of the same power is now required to bridge the same gap, thanks to this tube.

It was soon discovered that the sensitivity could be increased into the billions by using a quantity of such tubes connected together in a certain fashion. In technical terms, we use one tube as a "detector," and the balance of the tubes as "amplifiers." In other words, a weak signal, that is, totally inaudible, can be magnified to such an extent that the sounds come roaring out from a horn with ear-splitting intensity. But that is not all.

(*Continued on page* 219)

What Happens and Music

By JESSE

Above is Illustrated the Type of Microphone and Control Box Used for Announcing or Broadcasting from Remote Places. On the Right is the Double Microphone Used in the Studio.
© U. & U. and K. & H.

WHEN a speech or concert is broadcast from any given point, Newark for example, it reaches out over many, many miles all around it, and arrives at these distant points loud and clear in the receiving telephones. Did the reader ever stop to consider what an amazing feat this really is, that the voice of a singer can be thrown out hundreds of miles into space and heard distinctly? Stand on the corner of any street and try to talk to a person 10' away. You must raise your voice perceptibly. Let that person stand one block away from you and it is almost impossible for him to hear you no matter how high you raise your voice. Yet a singer in Newark is heard in Chicago as clearly and distinctly as though the singer were there in Chicago. Imagine how much energy there is involved when you utter the sound "AH" in a normal tone of voice. Hardly enough to blow a thin sheet of paper placed in front of your mouth. Place a thin piece of paper in front of your mouth and say "Ah" steadily. The paper will not budge visibly. The energy involved is so small that it is almost inconceivable that it could be sent out into space hundreds, and sometimes thousands of miles. Consider the ordinary telephone which may now be resting on your desk and which you use daily. When you speak into this the energy of your speech is amplified by batteries which are connected to the telephone. Yet the energy output of that telephone is only about 0.1 watt. How much energy is this? Just about enough to move a weight of one ounce through a distance of 1' in a second. Yet the voice of a singer which involves ever so much less energy than this is hurled out into space hundreds of miles. How is all this accomplished? Let us trace the path of the speech or the song as it leaves the speaker's or singer's mouth to find this out.

What applies to the singer applies equally to an orchestra or band or any other sound-producing mechanism.

Imagine a large room beautifully furnished and draped. It may contain a few chairs, a piano and a table. Apart from these there is no other furniture. The speaker or singer is in this room, perhaps with one of the broadcasting station officials. This room is not built like any other room in a building, but has been specially designed and constructed according to the best accoustical principles to avoid the production of echoes which might otherwise be transmitted with the original sounds. On the table there is what apparently looks like a neat piece of ornamental furniture, or it may be a long cylinder. Or this cylinder may be suspended or supported in mid-air. This is the so-called "microphone" which corresponds to the mouthpiece of the ordinary desk telephone. This microphone picks up the sounds as they leave the singer's or speaker's mouth and converts these sounds into electrical currents. The construction of the microphone is different from that of the desk telephone, although it accomplishes the same things. It is necessarily different for it has much harder work to do. It has to transform faithfully the most varied sounds from a deep bass to a high soprano, the queer sounds coming from a saxophone and those from a violin or piano, the complex sounds coming from a large orchestra or band. It must pick up each

Below is the Oscillograph Which Permits the Operator to See the Modulated Current and Adjust the Amplifier for Best Results.
(c) U. & U.

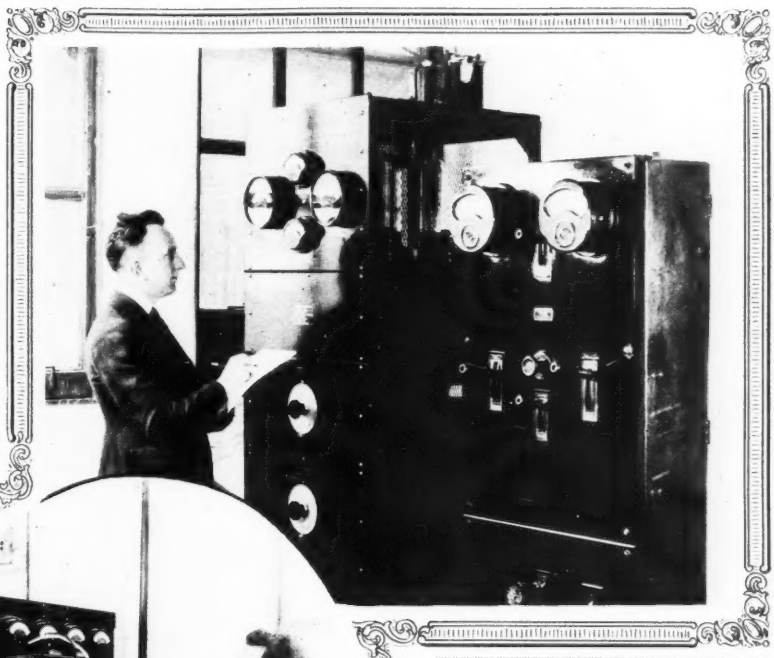
to the Speech When Broadcast

MARSTEN

of these varied sounds faithfully without omitting any or detracting from the quality of any individual sound. The desk telephone is built essentially for human speech as ordinarily used. Hence the microphone used in broadcasting is a much better and more complex device.

As stated, when the sounds leave the singer's or speaker's mouth they strike the microphone which is connected in an electrical circuit. These sounds vary from moment to moment, sometimes low, sometimes high. They produce certain changes in the microphone which changes correspond faithfully to the changes in the speaker's voice. The electrical current in the microphone circuit is correspondingly varied so that the electric current may be considered, as in fact it is, an exact electrical duplicate or photograph of the sounds which leave the singer's or speaker's mouth. However, the energy contained in the original sounds is minute or microscopic and as a result the energy in the electrical duplicate of the microphone is also extremely small. In order to utilize this small energy for broadcasting purposes, it is necessary to magnify it many times.

The electrical current in the microphone, which is the electrical counterpart of the original sounds leaving the performer's mouth, is therefore passed through a speech amplifier which consists essentially of the all-important vacuum tube amplifiers of which there may be three or four associated with specially designed electrical circuits. The microscopic currents are here magnified hundreds of times so that they possess much more energy than they did previously.



A Typical Radiophone Transmitter. On the Right is the Control Panel and on the Left the Transmitter Proper.

In the process of this amplification there is always great danger that the original electrical impulses, which were faithful duplicates of the sounds which left the performer's mouth may suffer distortion, in which case the sounds reaching the receiving station will not be like those originally transmitted. The speech amplifier has been specially designed not only to magnify the weak speech impulses, but also to duplicate faithfully without distortion these impulses. Coming out of this speech amplifier, then, are magnified electrical currents which correspond exactly to the original speech.

These Two Pictures Show the Type of Amplifiers Through Which the Voice and Music Are Amplified Before Reaching the Transmitter. An Operator Listens Constantly to Check the Quality and Volume. © *Photonews*

RADIO FREQUENCY TRANSMITTER

Let us leave the speech currents at this stage for a moment whilst we consider its function. What is required here is that the speech should be transmitted through the air over large distances. Now, speech currents cannot be transmitted alone, unmodified, through the air, no matter how much they are magnified. They have not the radiating power or ability because they do not vibrate rapidly enough. Only those currents can be radiated through space which vibrate very rapidly. Hence, even if we continued to use more and more speech amplifiers to magnify the original speech currents, we could not radiate this speech through space. What we require is something which does radiate in space and travel over far distances to carry these speech currents along with it. For this purpose we have a radio frequency transmitter connected to the antenna. The radio frequency transmitter generates those currents of extremely high frequency which are able to travel through space, and the antenna is the agency which hurls them into space. This radio frequency transmitter is likewise made up of those all-important instruments, vacuum tubes, only here more powerful ones are used than in the amplifier, for these tubes have to generate a strong enough current to radiate far out into space.

(*Continued on page* 186)

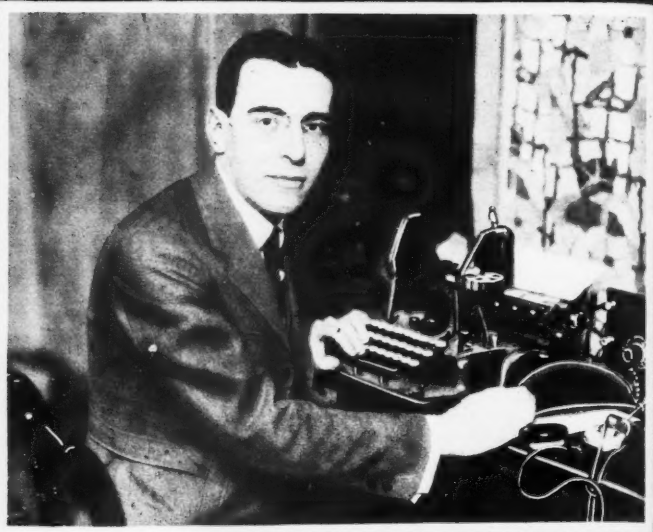
With the Broadcasters

ADVERTISING CLUB USES UNIQUE METHOD IN PREVENTING FRAUD

At a Wednesday meeting of the San Francisco Advertising Club, held in the Palace Hotel, Elliot M. Epsteen, general counsel of the Club, told in his report of a new method of preventing fraud.

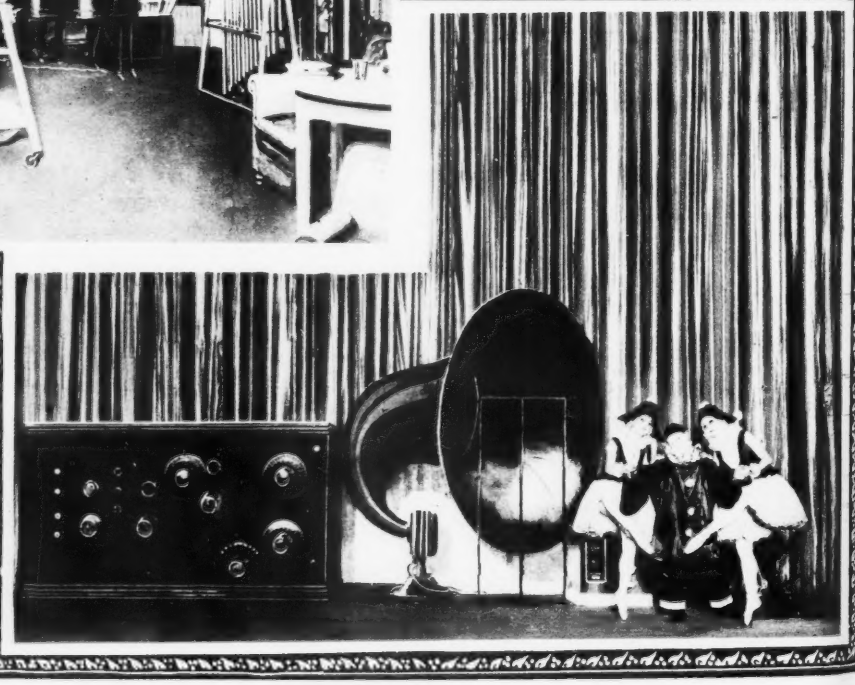
The Advertising Club enforces the "Truth in Advertising" movement. The Better Business Bureau is the division of the organization which deals with that phase of its activities.

Recently, Mr. Epsteen was invited by the Mercantile Trust Co., to speak over the "air" from its Telegraph Hill Station, KFDB, on the work of his organization. He went thoroughly into the work of the Better Business Bureau and showed how millions of



Above: Clyde A. Criswell, a Philadelphia Author, Has the Distinction of Writing the First Play Especially for the Unseen Radio Audience. One of Mr. Criswell's First Radio Dramas, "The Secret Wave," Has Already Been Broadcast by Station WDAR, Philadelphia, and One More Will Be Presented Each Week. © *Kadel & Herbert*

Left: The New British Radio Studio of the British Broadcasting Company, At Savoy Hill, London. In the Foreground is the Microphone Which is of Imposing Size; and on the Right the Chimes. © *U. & U.*



The Stage-Setting of "The Dream of a Radio Fan," a Recent Play, Staged at the Strand Theatre, New York City. The Entire Performance Was Broadcast from Radio Central, New York City.

dollars had been saved the public annually through the correcting of false and misleading advertising.

He stressed the fake oil promotions and offered to give disinterested information to any person who desired it.

The next day, an inquiry came from Burlingame. The writer stated that he had a home-made crystal set, and was about to invest in a Texas oil promotion. He sent the mail matter sent to him. With it was an annual report of the company. After telling of its glowing "intentions," it reported an annual meeting. It told that the auditor did not yet have his financial report ready. It told of how only $650,000 was yet due on purchased land, and stressed as its

(*Continued on page* 196)

The Wave Filters

By W. PALMER POWERS

ASSISTANT PROFESSOR OF ELECTRICAL ENGINEERING STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, N. J.

ANY device which will in some measure relieve the interference situation is of interest to the radio broadcast fan. It is the purpose of this article to discuss the question of interference and point out some of the usual methods of improving the selectivity, emphasizing particularly the use of the so-called "filter" or "wave trap."

Radio signals are transmitted in the form of radiated energy. In the transmitting aerial there is a current which is varying at a regular frequency, and a wave is detached from the transmitting aerial for each complete cycle of the aerial current. It appears that these waves do not accumulate along the way, and it is then apparent that each wave is pushed along in space by the succeeding wave. (Somewhat as a wave resulting when a stone is dropped into a pool of water.) This being true, we may say that the first wave has reached a distance equal to the number of waves emitted, times the length of each wave. It has been determined that the velocity of these waves is constant and approximately equal to 300,000,000 meters per second. We are then in a position to say that the velocity equals the frequency times the wave-length; for the first wave will, at the end of one second reach a distance equal to the number of waves emitted (frequency) times the length of each wave (wave-length). This expression is of great importance, because it enables one to express the wave-length in terms of the electric circuits.

VELOCITY = FREQUENCY × WAVE LENGTH

Wave-Length Meters	Frequency Per Second
300	1,000,000 cycles
600	500,000 cycles
1,000	300,000 cycles

When several broadcasting stations are operating simultaneously, they may cause considerable confusion at the receiving station because of the fact that they cannot be separated. They are said to be operating on different wave-lengths, and from the foregoing statements it is clear that they are emitting waves of different frequencies.

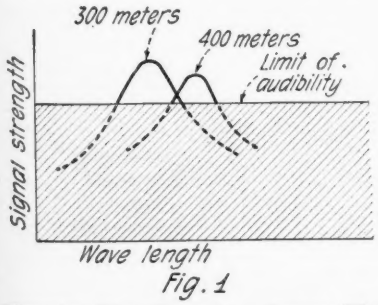


Fig. 1

Illustrating What Occurs in a Receiver When Two Stations Are Audible.

If it were possible to transmit signals on a specific wave-length, or frequency, we would have little difficulty in separating stations even if they were adjusted to nearly the same wave-length. This, however, is not possible since modulations, such as voice waves, cause a change in the carrier-wave frequency. We find that our receiver responds to several wave-lengths on a single adjustment. Stations are considered "broad" and "sharp," depending upon the manner in which they tune. The result of this chaotic state of affairs is due to the fact that the transmitted energy is distributed over a band of wave-lengths or frequencies, and to the fact that our receivers do not possess the ability to select certain frequencies and reject all others. Fig. 1 illustrates what occurs in a receiver when two stations are audible.

METHODS OF ELIMINATING INTERFERENCE

The simplest method of eliminating interference is to arrange the transmitters on widely different wave-lengths. This, however, has been quite impossible until very recently, owing to the fact that certain legislation has required that all broadcasting be conducted on a narrow band of wave-lengths. With the new assignment of wave-lengths, we may expect considerable relief, but it is well to remember that the period through which we have just passed has at least provided the incentive to produce selective receivers.

It is generally understood that the multi-circuit receivers are more selective than the single-circuit receivers. The selectivity increases with the number of circuits, but the complexity of control also increases, resulting frequently in a selectivity actually below that of the single-circuit type. Very good results can, however, be obtained with a properly designed single-circuit receiver and the simplicity of operation is a point of interest to many.

The wave filter, as the name implies, is a device which allows a certain wave to pass and rejects all others. It is usually constructed as a separate unit, and may be used with any receiver. It is simply a device which establishes high impedance for a particular wave (frequency). Such a filter, if placed across any circuit, say from aerial to ground, will pass (short circuit) all undesired frequencies, but will reject the desired frequency, this frequency taking the path through the receiver, which, of course, is tuned to the desired frequency. Such an arrangement is indicated in Fig. 2.

If interference from one station only is experienced, the filter may be put directly in the aerial circuit, in series, as shown in Fig. 3.

The filter is now adjusted to the undesired frequency. It rejects the undesired frequency, but allows the adjustment of the entire circuit, by adjustment of the receiver, for any desired frequency. The adjustment of the receiver under these conditions is a little peculiar, owing to the presence of the filter, and the following detailed explanation of the filter characteristics is therefore given.

FILTER CHARACTERISTICS

The simple wave filter is composed of a parallel combination of inductance and capacity, as shown in Fig. 4.

Such a circuit, when tuned, appears as a high resistance to the resonant frequency. It does not, however, seriously impede the other frequencies. The higher frequencies (shorter waves) pass through the condenser, while the lower frequencies (longer waves) pass through the inductance. It is then apparent that the filter appears as a capacity for the frequencies higher than the resonant frequency, and it appears as an inductance for frequencies lower than the resonant frequency. If these points are kept in mind, receiver adjustments when using Fig. 3 are easily explained.

Suppose, for instance, that we are rejecting a 400-meter signal, and we are adjusting for reception of a 300-meter signal. The filter is first set for 400 meters, the wave-length markings having previously been determined by the manufacturer. Under this adjustment, 400

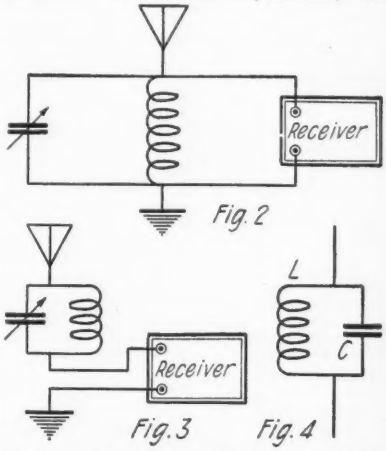


Fig. 2

Fig. 3

Fig. 4

Figs. 2 and 3 Show Two Manners In Which a Wave Filter Can Be Connected To a Receiver. As Described In This Article, the Resultant Effects of the Two Are Not the Same. Fig. 4 Shows a Simple Non-Variable Wave Filter.

meters, the filter appears as a condenser for 300 meters. It is, therefore, necessary to increase the inductance of the receiver beyond the point originally used for 300 meters. This increase in inductance is not generally appreciated. In like manner, where rejecting a 300-meter signal and receiving a 400-meter signal, the filter is first adjusted to 300 meters. The filter under these conditions appears as an inductance in the aerial system for 400 meters. It is, therefore, necessary to reduce the inductance of the receiver to receive the 400-meter signal.

If the receiver is the type which tunes with a series condenser in the aerial circuit, it is only necessary to remember that increasing the series condenser setting is equivalent to increasing the series inductance.

A very serviceable filter covering the present broadcast range can be made by using 60 turns of No. 28 D. C. C. copper wire wound closely on a tube of insulating material 3" in. diameter, connected in parallel with a good variable condenser of .0005 microfarad capacity.

TEACHING FOREIGN LANGUAGES BY RADIO

A wireless experiment of great interest is to be made at Sheffield, England, soon. General Ferrie, Director-General of Radio Services to the French Government, has agreed to wireless to three Sheffield schools fitted with listening-in sets a fable and a poem in French.

If the experiment is successful, Mr. F. Lloyd, President of the Sheffield and District Wireless Society, who is collaborating with the Sheffield Education Committee and with General Ferrie, believes it will lead at an early date to scholars in all the principal countries getting a first-hand grasp of foreign languages by listening-in to the teaching in native schools in each country of English, French, German, Italian, or Spanish, as the case may be.

Electrons, Electric Waves and Wireless Telephony

By DR. J. A. FLEMING, M. A., D. Sc., F. R. S.

PART VII

IN arrangements for wireless telephony employed before the application of the thermionic valve as a generator of continuous waves, it was necessary to modulate rather large currents of 5 to 10 amperes by a microphone transmitter.

The carbon granule telephone transmitters in ordinary use, such as those above-described, will not operate satisfactorily with

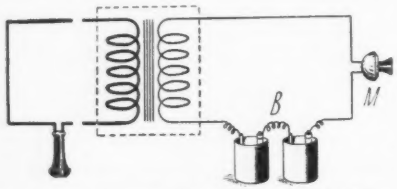


Fig. 78. A Diagram Illustrating a Simple Telephone Circuit. M is the Carbon Microphone Transmitter, B is the Battery, T the Telephone Induction Coil, and R is the Receiving Telephone.

more than about half an ampere of current passing through them. Hence many arrangements were suggested for using a number of transmitters in parallel or together, but it is extremely difficult to secure an equal division of current between the instruments so that all the microphones shall take an equal share of the duty of modulating it These arrangements need not be described, as they are now rendered unnecessary by the powers and remarkable properties of the thermionic valve as described later on. It is, however, necessary in nearly all cases to associate with the microphone an induction coil for the following reasons.

The variation in resistance of the carbon granule microphone is, in general, only a fraction of its normal resistance, which may be from 30 to 100 ohms. Suppose, then, that such a microphone, in series with a few cells of a battery, is placed in a circuit which has a much higher electrical resistance than the microphone itself. It will be evident that any variation in resistance of the microphone produced by speech made against the diaphragm will only vary the total resistance of the circuit by a much smaller percentage than that by which the resistance of the carbon microphone itself is varied (see Fig. 78).

This difficulty is overcome by the use of

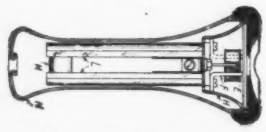


Fig. 79. British Post Office Type of Magneto-Telephone Receiver.

an induction coil as first suggested by Edison. We provide a small induction coil T, consisting of two insulated wires wound over a small bundle of iron wires (see Fig. 78). The resistance of one primary wire may be about 1 ohm, and the resistance of the other, or secondary wire, may be about 25 ohms. If, then, we join in series the primary wire and the carbon microphone M and a battery B of a few low-resistance cells, it will be evident that any variation in the resistance of the carbon microphone due to vibrations of its diaphragm will create variations in the current flowing through the circuit of nearly equal percentage to the variations in microphone resistance. Then any changes in the current flowing through the primary wire of the induction coil will create corresponding variations in the electromotive force induced in the secondary wire.

The line wires are attached in ordinary wire telephony to the terminals of this secondary circuit, so that the current transmitted is an induced current, and this passes through the receiver telephone R at the listening end.

In the case of wireless telephony, as will be explained later on, the secondary electromotive force is used to vary the potential of the grid of a thermionic valve called a control valve.

A method which avoids the use of an induction coil is to join a number of microphone transmitters in series so that they are all equally affected by the voice, but the total resistance variation is then the sum of the variations of each microphone separately.

The construction of the Bell magneto-receiving telephone has been the subject of numerous improvements in details of construction. In place of a single steel bar magnet as originally used, two bar magnets made of tungsten steel are used, which are fixed

The articles appearing under the above title are a reproduction with some additions of the Christmas Lectures on Electric Waves and Wireless Telephony given by Dr. J. A. Fleming, F.R.S., at the Royal Institution, London, in December and January, 1921-1922. RADIO NEWS has been able to secure the serial rights of publication in this country. The articles are therefore copyright, and rights of publication and reproduction are strictly reserved.

parallel to each other at a little distance apart, and connected at one end by an iron distance piece. Or else an elongated horseshoe magnet is employed (see Fig. 79). On the free outer poles are fixed L-shaped soft iron pole pieces on which coils of insulated wire are wound. The magnets are contained in a non-magnetic metal tube, which is wider at the outer end. On this outer end is fixed a thin disc made of a steel called "Stalloy," which contains about 2.75 per cent. of silicon. This style disc is about 2¼" in diameter, and 1/100th" in thickness. This diaphragm is so fixed that there is an interspace of about 0.016", or about 1/60th of an inch between the flat ends of the pole pieces and the inner surface of the metal disc. The lines of magnetic force which spring from one pole of the magnet pass across this air gap through the iron diaphragm, and back across the air gap to the other magnet pole. The circular diaphragm is therefore sucked or cupped in at the centre, due to the magnetic pull of these poles. If, then, an electric current is sent through the coils of wire wound on the pole pieces it will either increase or else weaken this attraction. If we call H the magnetic force due to the magnet alone, and h the magnetic force due to the current in the coils, then the force can vary from $H + h$ to $H - h$, according to the direction of the current. The attraction or pull on the diaphragm varies as the square of the magnetic force or flux, as it should be called, and hence the attractive force varies between $(H + h)^2$ and $(H - h)^2$. The difference is $4Hh$, and hence depends on H as well as h. It is therefore important to have magnets in the receiver as strong as possible. The material generally used for them is steel containing 5 or 6 per cent. of tungsten, and 1 or 2 per cent. of chromium. The finished magnets are made very hard by quenching from a red heat in ice-cooled water to give

Fig. 81. Double Head Telephone Receiver with Spring Head Band (S. G. Brown).

them the power of retaining magnetism. Recently a type of steel has been invented at Sheffield called *cobaltorom*, containing about 15 per cent. of cobalt and 15 per cent. of chromium. It has a much higher magnetic coercive force than tungsten steel. Moreover, it stores up about double the magnetic energy for the same volume of metal. It has the great advantage that it does not require hardening from a red heat in a liquid, and hence the finished magnets are not so liable to be warped out of shape in quenching.

It is important that the small air gap between the magnet poles and the diaphragm should remain of perfectly constant width. The coils of wire wound on the soft iron pole-pieces are made of fine silk-covered copper wire, and may be of resistance between 60 ohms and 4,000, according to the purposes for which the receiver is used.

In wireless telephony the type of receiver generally employed is called a double head telephone. It has two receivers of watch-shape, attached by flexible joints to a steel or aluminum head-band, which passes over the top of the operator's head and holds the two receivers against the ears.

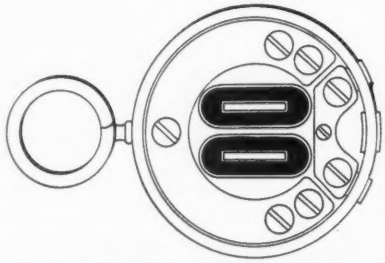


Fig. 80. Watch Form of Magneto-Telephone Receiver with the Diaphragm Removed to Show the Magnet and the Coils.

The receivers are in circular watch-shaped cases, made of ebonite or aluminium (see Fig. 80). The magnets are flat rings of steel, with L-shaped soft iron pole pieces screwed to them, on which are wound rectangular shaped coils of extremely fine silk-covered copper wire (No. 40, or even No. 60, standard wire gauge), so as to obtain a very high resistance of 2,000 to 4,000 ohms. The

two receivers on the headband have their coil circuits in parallel (see Fig. 81).

In the case of loud-speaking receivers the construction is the same as in the portable receivers, but the magnets and diaphragms are larger, and a trumpet-shaped sound projector, like the horn of a gramophone, is attached. A very good example of this type of instrument is the loud speaker of Mr. S. G. Brown, by which telephonic speech can be heard by several hundred persons at once in a large theatre (see Fig. 82).

Mr. Brown has also invented very excellent forms of double head telephones which are in extensive use for wireless telegraphy and telephony. He has devised a form of aluminium head-band and self-adjusting swivel receiver holders, which are comfortable to wear on the head, and by which the receivers are kept gently pressed against the ears (see Fig. 81). The electrical construction of the receivers, as used for wireless telegraphy, is somewhat different to the standard magneto pattern. In place of an iron diaphragm there is an iron reed, or strip of iron, the natural vibration frequency of which can be adjusted by a screw within limits. To this is screwed an aluminum diaphragm, which is coned and spun into a special fitment, which is covered by an ebonite cap with holes in the center (see Fig. 83). The resonance frequency of this receiver can therefore be adjusted to suit the musical note of the wireless signals in telegraphy.

In the case of receivers for wireless telephony this adjustment is not required, but the resonance frequency is adjusted to agree with the mean or standard telephone frequency, generally about 800 or 900 cycles per second. The coils of receivers for wireless elephony in use with valve or crystal receiving sets are now always wound with a direct current resistance of about 4,000 ohms.

EFFICIENCY AND PROPERTIES OF THE TELEPHONE RECEIVER

The remarkable fact about a Bell magneto telephone is that the mere vibrations of a small flexible circular iron disc should be capable of impressing on the air waves having the very irregular wave form necessary to create speech sounds. When we consider the complicated nature of our own human organs of speech and the manner in which the larynx, throat muscles, variable mouth cavity, lips, tongue and teeth, are all brought into operation to create articulate sounds, it is wonderful that the mere to and fro motion of a small thin iron disc can do nearly the same thing in creating speech. Another striking thing is the very small electric currents which are cpaable of creating audible sounds in a telephone receiver, and the extremely small amplitude or extent of motion of the telephone diphragm in creating such sounds. P. E. Shaw measured, in 1905, the amplitude of diaphragm motion for a just audible sound in a magneto receiver, and found it to be about one-fourteenth part of a millionth of a centimeter, or about one-thirty-fifth part of a millionth of an inch.

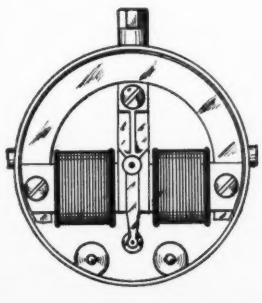


Fig. 83. Interior Construction of the Resonance Telephone Receiver of S. G. Brown, Showing the Vibrating Steel Reed.

The diaphragm of a telephone has, however, a certain natural frequency to which it best responds. It resembles a violin string or harmonium reed in that there is no particular natural frequency at which it will vibrate and yield its fundamental note if it is struck and left to itself. This frequency is called its *resonance frequency*, and in telephones with iron diaphragms about 2 in. in diameter and 1/50th in. thick, the resonance frequency is about 800 or 900. Hence, if we pass through the telephone coils an alternating electric current having this resonance frequency, the amplitude of motion of the diaphragm will be increased from 10 to 30 times when compared with that which it would have for the same current at a different frequency.

In connection with telephone work we require to give numerical values to the loudness of various sounds heard in the telephone. This is stated in terms of their *audibility*. If we pass an alternating current through a telephone of any frequency between, say, 100 and 2,000, we hear, on listening to the receiver, a more or less musical sound. If we apply across the terminals of the telephone a resistance called a shunt, which has no inductance, and gradually decrease this resistance, we shall at last reach a point at which the telephone sound is only

Fig. 82. Loud Speaking Telephone of S. G. Brown

just audible, because part of the current is shunted away from its coils. If the resistance of the telephone coils in R ohms, and the resistance of the shunt is then S ohms, then the *audibility* of the sound when the shunt is removed is expressed by the number $(R+S)/S$. Strictly speaking, we should say impedances and not resistances. Thus, suppose the telephone had an impedance of 100 ohms, and that we had to shunt the telephone with 2 ohms to just make the sound heard in the telephone inaudible to a normal ear, then the so-called audibility of that sound when the shunt is removed would be 102/2=51.

Shaw found that if the audibility of a just perceptible sound is taken as unity, then the audibility of a loud sound would be about 1,400, and that of an overpowering sound 7,000 or more. Broadly speaking, we may say that the intensity of the sounds emitted may vary from 1, which denotes a just audible sound, to 1,000, which denotes a fairly loud sound.

The displacement or amplitude of motion of the diaphragm may vary from about half a micron ($=5\times10^{-6}$ cm.), which is about the wave-length of a ray of yellow light, to 8 or 10 microns, which is about 1/100th of

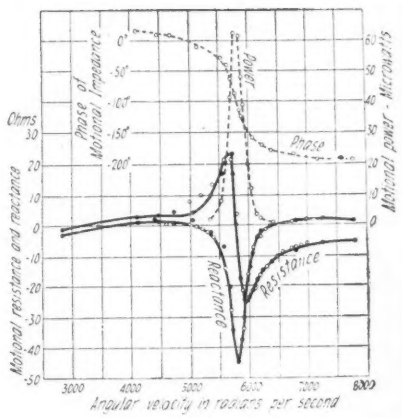


Fig. 84. Curves Obtained by Dr. A. E. Kennelly for the Motional Resistance, Reactance and Power Absorption of a Magneto-Telephone Receiver. Note: The Angular Velocity Signifies 6.28 Times the Frequency of the Alternating Current.

a millimeter. Even in the case of loud telephonic sounds it is very small.

As regards the currents required to produce sounds of various audibilities, Werner Siemens long ago found that with a particular Bell telephone, the interruption of a current of 1/50,000th of a milliampere, when passed through the coils, caused the diaphragm to emit a just audible sound or tick. With more modern receivers the starting or stopping of a current of not more than 1/6th of the above could be detected. If, however, alternating currents are used, the current producing a just audible sound would depend upon whether the frequency of that current agreed with the telephone resonance frequency or not.

Another very remarkable quality of the magneto telephone is its astonishing inefficiency as an energy transforming device. We employ a magneto telephone to transform the energy of the varying electric currents sent through it into energy of aerial sound waves. But the fraction of the energy it so transforms is at most about 1/1,000th or 1/10th of 1 per cent., and, except at resonance frequency, may be only a few parts in 100,000.

The greater part of the electric power given to the coils of a telephone receiver is expended in producing heat in the wire coils and in the diaphragm, in mechanical work in bending the diaphragm and moving it to and fro, and in magnetic energy losses in it, and at most one or two parts in 1,000 of all the power applied is utilized in the production of the speech sound waves.

There is therefore a vast field for possible improvements, and it is curious that, with the exception of the hot wire telephone or Thermophone receiver of De Lange and O. Fischer, invented in Holland, there has been no great departure from the principles of Bell's invention made 47 years ago, although very considerable improvement has taken place in details and in manufacture.

Much research has also been conducted on the properties of the magneto telephone receiver. Many interesting monographs have been published by Prof. A. E. Kennelly and his associates in the Massachusetts Institute of Technology, U. S. A. Kennelly has made measurements, at various frequencies and with different receivers of standard types, of the true resistance, the reactance, and the impedance of the telephone coils.

In general the resistance of a telephone is reckoned as the resistance to direct currents. Thus we speak of a 60-ohm telephone, meaning one of which the coils measure 60 ohms with direct current. The speech currents are, however, alternating currents with a frequency varying from 100 to 2,000, and a mean value of about 800 or 900, corre-

sponding to the resonance frequency of the telephone. The resistance R with high frequency currents is much greater, perhaps double or more, compared with the direct current resistance. Again, if we measure the inductance L of the coils at any frequency n, then the product $2\pi nL = \omega L$ is called the *reactance* of the coils, and the quantity $\sqrt{R^2 + \omega^2 L_2}$ is called the *impedance*.

If the resistance, reactance, and impedance of a telephone receiver are measured at the

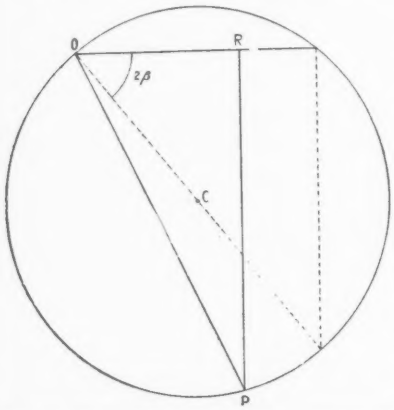


Fig. 85. Circle of Motional Impedance Constructed by Plotting the Motional Resistance Horizontally OR and the Motional Resistance Downwards Vertically RP, the Diameter of the Circle Measuring the Impedance of the Telephone.

same frequency—first when the telephone is emitting sound, and secondly with the diaphragm clamped so that no sound is emitted—and if we subtract the second measurements from the first, the difference gives us the so-called *motional* resistance, reactance, and impedance of the telephone. If these are measured at different frequencies and the values plotted as the ordinates of a curve corresponding to the various frequencies as abscissae, we obtain a set of interesting curves (see Fig. 84). The motional resistance at frequencies far from the resonance frequency is small, then it rises to a maximum, and then suddenly falls to zero at resonance, and passes to a negative maximum. The motional reactance is always negative and a maximum at resonance. The motional power is a maximum at resonance; that means when the frequency of the alternating current used in the measurement agrees with the natural frequency of the telephone diaphragm.

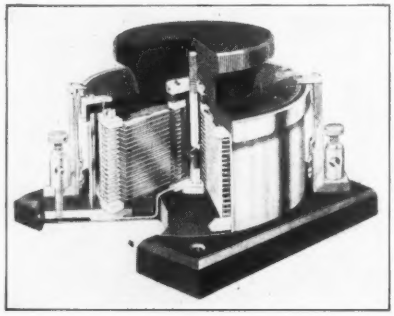
On the other hand, if we plot the motional resistance horizontally and the motional resistance downwards vertically (see Fig. 85), we obtain a circle called the *motional impedance circle*, the diameter of which measures the impedance of the telephone at resonance frequency. The angle which any chord of this circle makes with the horizontal line is called the *depression* angle, and this angle is double of the angle by which the magnetic flux in the telephone magnet lags behind the magnetizing force.

PRODUCTION OF CONTINUOUS ELECTRIC WAVES

It is now possible to gather up the threads of all previous explanations and utilize them in making an exposition of the principles and mode of operation of the wireless telephone, which is certainly one of the most wonderful of all the achievements of technical science.

To conduct wireless telephony as contrasted with telephony with line wires, we have to replace the line wire by some agency which will enable us to transmit energy and yet permit us to employ the usual type of microphone transmitter and magneto-receiver used in ordinary telephony with wires at the sending and receiving stations. It has been found that we can do this by substituting for the connecting wire a stream of undamped or continuous high frequency electro magnetic waves. We must, then, first explain how these waves are created.

There is only one method practically employed at present in small plants, or those of moderate size, and that is by means of the thermionic valve. We have already explained that an incandescent tungsten filament in vacuo emits a torrent of electrons, and that these in the three-electrode valve make their way through the apertures of the surrounding grid and fall upon an anode or collecting plate. To make them do this the anode must be kept at a high positive potential so as to attract to it the negative electrons. This is done by means of a battery, dynamo, or other source of direct electromotive force. The anode must be connected to the filament by an external circuit which includes the above-mentioned source of electromotive force, but also a coil of wire called the plate circuit coil. This plate circuit coil has also its terminals connected to a condenser of a certain capacity, so that the coil and condenser, taken together, provide a circuit in which electric oscillations can take place with a certain natural frequency determined by the capacity of the condenser and the inductance of the coil in accordance with rules already given.



By Courtesy of Marconi Wireless Telegraph Co., Ltd.
Fig. 87. An Air Condenser of Variable Capacity Formed With a Set of Fixed Semi-Circular Metal Plates and Similar Movable Plates, Which Latter Can be Brought More or Less Into Proximity to the Former by Rotating the Ebonite Head of the Axis Carrying the Movable Plates. Part of the Condenser in This Illustration is Shown Cut Away So as to Enable the Structure to be Seen and Understood.

If, then, the grid is connected to the filament through another circuit which also includes a coil of wire, and if this last coil, called the grid circuit coil, is placed near to the plate circuit coil and in a certain position, any change in the current in the plate circuit coil will create an induced electromotive force in the grid circuit coil, and this in turn will alter the grid potential and charge the grid either negatively, that is, put more electrons into it, or positively, that is, take free electrons from it. When the grid is made negative it will reduce the electron stream flowing from the filament to the plate, and reduce the current in the external plate circuit or coil. By a proper mode of connection it is possible to make the changes of grid electrification of such sign and nature as to sustain the fluctuations of the plate current, which, in turn, by the mutual inductive action of the plate and grid coils, create the appropriate variations of grid potential.

The grid and plate coils are then said to be coupled for production of oscillations. The plate current then consists of a steady direct current, on which is superimposed an alternating current, or the plate current fluctuates in strength. The power required to produce these oscillations comes from the battery in the plate circuit, but the power is transformed from direct current (D.C.) power to alternating current (A.C.) power.

The action of the thermionic valve in this respect has been compared with a steam engine. The steady pressure of the steam is applied to push forward the piston, but to make the piston oscillate or move backwards and forwards alternately, the steam must be admitted to the cylinder by means of the slide valve, first on one side of the piston, and then on the other. To make the engine self-acting we have to connect the slide valve by some mechanism with the piston so that motions of the piston move the slide valve in the proper manner to maintain the oscillations of the piston. The steam may be compared with the electrons emitted by the filament; the grid is analogous to the slide valve, and the external plate current to the motions of the piston.

The above analogy is, however, very imperfect, and a much better one is as follows: If we connect together in series a Bell magneto telephone, a carbon granule microphone transmitter, and a couple of cells of a battery, a current will flow through the carbon and through the coils of the telephone. If we hold the diaphragms of the transmitter and receiver near together the receiver will emit a shrill musical note, and continue to emit it as long as the two instruments are close together.

The reason is as follows: Small noises in the room set the diaphragm of the transmitter in vibration. This causes compression of the carbon granules, and in turn varies the current, and this makes the receiver emit a sound. This sound actuates the transmitter, and this again reacts on the receiver. Hence continuous sound waves are emitted by the system, and the power to produce them is drawn from the battery.

Just as this coupled receiver and transmitter generate low frequency oscillations of electric current in their circuit, so the coupled thermionic valve circuits react on each other and create high or low frequency electric oscillations in the plate circuit according to the capacity and inductance in the circuit. To radiate electromagnetic waves we have to utilize these oscillations to produce similar oscillations in an *aerial wire*, or radiative circuit. The simplest method, then, of producing undamped or continuous waves (C.W.) by a thermionic valve is by an arrangement as follows:

Let V (see Fig. 86) be the valve of which P is the plate or anode cylinder, G the grid, and F the filament. Let B_1 be the battery which provides current for incandescing the filament, and r the regulating resistance. Let the grid be connected with the filament through a coil of wire L_2, called the grid coil, and let the plate P be connected with the filament through another coil L_1 and a key K and high voltage battery B_2 giving a voltage of 200 to 400 volts or more. The negative terminal of B_2 must be in connection with the filament. This battery B_2 must be shunted by a condenser C_2. The coil L_1 is also shunted by a condenser C_1. If the degree of coupling or closeness of the coils L_1, L_2 is

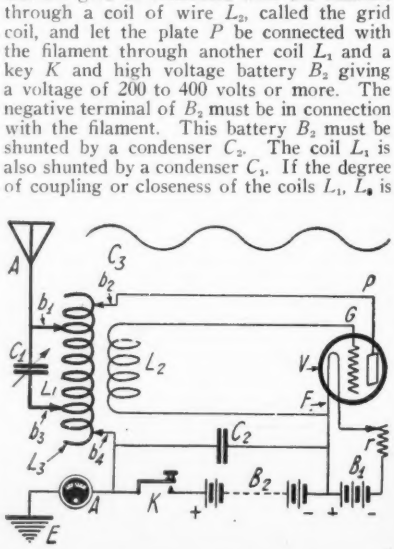


Fig. 86. Arrangement of Circuits for Producing Continuous Electric Waves (C.W.) by a Thermionic Valve.

adjusted, and the direction of their mutual inductance correct, then, as already explained, continuous oscillations will be set up in the circuit of L_1 which are superimposed upon the steady or direct current produced by the battery B_2. The frequency (n) of these oscillations will be determined by the capacity of the condenser C_1 and the inductance of the coil L_1 in such fashion that—

$$n = \frac{5033}{\sqrt{C_1 L_1}}$$

The capacity C_1 must be measured in microfarads or fractions of a microfarad, and L_1 must be measured in millihenries, or fractions of a millihenry, and the square root of the numerical product of C_1 and L_1 divided into the number 5033.

The condenser C_1 is connected to the coil L_1 by sliding contacts b_1, b_3 so that the inductance L_1 can be varied. Also the condenser C_1 is an adjustable capacity indicated symbolically by the arrow crossing two parallel black lines.

In actual practice the coil L_1 is made by winding enamelled copper wire in close turns on an ebonite or fibre tube about 4 or 6 ins. in diameter. The enamel is then scraped or rubbed off a narrow strip parallel to the length of the cylinder, and enables rubbing contacts of brass to be slid along a bar and so make contacts at places b_1, b_2, b_3, b_4, as desired with the copper wire. The condenser C_1 is made of a number of semi-circular plates of aluminium spaced a little way apart, which are attached to an axis. These plates are so fixed that they can be turned to sandwich in, more or less, between a number of fixed semi-circular plates. The fixed and movable plates are the two plates of the condenser, and by rotating the movable plates so as to bring them more or less in between the fixed plates, the capacity of the condenser is varied (see Fig. 87).

RADIATION OF CONTINUOUS WAVES

We have next to make provision for using these oscillations to create continuous electric waves. We have seen that when high frequency oscillations are set up in a straight rod or wire with metal plates at the end, called a Hertzian oscillator, the result is to radiate electromagnetic waves which we have

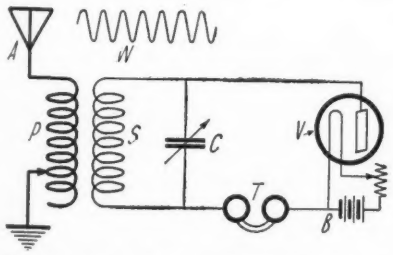


Fig. 88. Simple Form of Receiving Circuit for Wireless Telephony. A is the Aerial, P the Aerial Tuning Coil, C is the Tuning Condenser and V a Fleming Rectifying Valve, T is the Telephone. W Represents the Arriving Carrier Waves.

explained to be vibrations propagated along the electro-lines proceeding from the free electrons in the wire, the rapid to and fro movements of which are the electric oscillations in that wire.

This radiation is effected by connecting to the contact b_1 an aerial wire A, which consists of two or more copper wires which rise vertically into the air a certain height, and then run horizontally a certain distance, and are insulated at the far or free end (see Fig. 86). At the same time we connect another point b_4 on the inductance coil L_1 through a current-reading instrument A, called a hot wire ammeter, to a plate E sunk in the earth, or it may be the water pipes of a building.

The aerial A has a certain electrical capacity with respect to the earth, and may be regarded, therefore, as another condenser joined across a section of the coil L_1 between the points b_1 and b_4. By suitably choosing the points of contact b_3 and b_4, we can tune together the oscillatory circuits composed respectively of the condenser of capacity C_1 and the section L_1 of the inductance coil, and also the capacity C_3 of the aerial and the section $L_1 + L_3$ of the inductance coil by making the adjustments so that the product $C_1 L_1$ is equal to the product $C_3 (L_1 + L_1)$.

If, then, we close the key K, the battery B_2 will send a stream of electrons from the filament of the valve to the plate, and they will find their way back through the coil L_1. If the grid then becomes slightly negative the electron stream from the battery will be reduced, and by the inductive action of the coils L_1 and L_2 this reduction of plate current can be made to give the grid a slight positive charge, and this then increases the electron stream. Accordingly fluctuations are set up in the plate current. The object of the condenser C_2 shunted across the high voltage battery is to provide a path for the high frequency oscillations thus created in the plate circuit. The varying potential of the terminals of the condenser C_1 then sets up sympathetic oscillations in the aerial wire, and this results in electromagnetic waves being radiated from it in an uninterrupted stream. The ammeter A placed just above the earth plate E then indicates a steady high frequency current, which is called the aerial current.

In the actual apparatus the two coils L_1 and L_2 are wound on ebonite tubes or in flat spirals, and so arranged that they can be brought near to or separated from each other to vary the mutual inductance. This coupling must exceed a certain value if the oscillations are to be created by the thermionic valve and electric waves radiated from the aerial. We can determine the frequency of the oscillations when we know the wave-length required or used from the simple relation—

frequency × *wave-length* = *velocity of wave.*

The velocity of electromagnetic waves through air is nearly 300,000 kilometers per second. Hence, to produce a wave of 300 meters wave-length requires oscillations at the rate of one million per second in the aerial. The standard wave-lengths for amateur wireless telephony and for "broadcasting" lie between 350 and 425 meters. Hence a 400 meter wave requires 750,000 oscillations per second in the aerial. Let us then suppose that we have set up at some place, an aerial and continuous wave (C.W.) generating valve plant, as above described. We can suppose it set in operation and to radiate continuous waves say of 400 meters wave-length. These waves are called the *carrier waves.*

Next, suppose we have at some other place a receiving station at which there is an aerial properly tuned to the wave-length of the wave sent out by the generating station, and that this receiving aerial is coupled to another closed oscillatory circuit comprising an inductance coil and a condenser with the capacity adjusted to tune it to the aerial circuit (see Fig. 88).

The waves from the transmitting station would strike the aerial of the receiving station and would set up in it feeble electric oscillations of the same frequency. These would generate other similar oscillations in the associated closed condenser circuit. The terminals of this last condenser would then alternate in potential alternately being positive and negative.

Suppose, next, that we connect these condenser terminals to the plate of a two-electrode rectifying valve in series with a telephone, as in Fig. 88.

The valve when its filament is incandescent would permit negative electricity or electrons to pass from the filament to the plate inside the bulb, but not in the opposite direction. Hence, the telephone coils would be traversed by a steady unidirectional or direct current.

This kind of current produces no effect on the telephone except to create a slight "tick" or sound at the moment the steady current begins or ends. Suppose then that we insert in the external grid circuit of the valve in the transmitting apparatus the secondary circuit of a small telephone induction coil I (see Fig. 89), and in the primary circuit of the coil a carbon microphone M

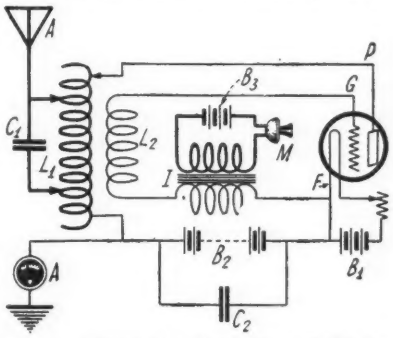


Fig. 89. Circuits of a Simple Form of Wireless Telephone Transmitter, Showing the Speaking Microphone M Coupled Inductively Through an Induction Coil I to the Grid Circuit L-2 of the Thermionic Valve.

and battery B_3. If we speak to this microphone mouthpiece the result will be to create in the grid circuit a fluctuating electromotive force, which will have the wave form of the speech sound, and will have a low frequency or *audio-frequency* as it is called, because it falls within the limits of the frequencies used in audible speech.

The effect of this will be to increase or diminish the amplitude of the carrier waves radiated. In other words, the speech made to the carbon microphone M will modulate the amplitude or height of the carrier waves exactly in accordance with the frequency and wave form of the aerial vibrations made by the voice of the speaker.

Let us then consider what the effect of this will be on the receiving apparatus just described. Any increase or decrease in the amplitude of the carrier waves will increase or decrease in the same proportion the direct or rectified current which flows through the magneto telephone in series with the rectifying valve. Hence, if speech is made to the microphone transmitter inserted in the grid circuit of the transmitting valve, the current in the sending aerial, and the amplitude of the carrier waves and therefore the current through the Bell telephone in the receiving current, will vary or change in nearly the same manner as the changes of air pressure made by the voice of the speaker near the microphone.

PRACTICAL FORMS OF WIRELESS TELEPHONE APPARATUS

In actual practice the apparatus is a little more complicated. The high voltage required for the plate of the transmitting valve is not always obtained from a battery but from a direct current dynamo, which gives a voltage of several hundred, or even a couple of thousand volts.

Then the modulation of the plate current is not accomplished by placing the microphone-induction coil in the grid circuit of the oscillating valve, but in that of another valve called the control valve.

Lastly, the high voltage of the plate of the generating valve need not be obtained from a direct current dynamo, but by rectifying a low frequency alternating current.

These modifications will best be understood by the description of certain typical forms of wireless telephone transmitter in actual use.

(*To be continued in the next issue*)

Detection

AN EXPLANATION OF HOW RADIO SIGNALS ARE MADE AUDIBLE

By LOUIS FRANK

THE radio waves which carry the transmitted speech or dot and dash telegraph signals travel through space all around the transmitting antenna at the speed of light, namely 186,000 miles per second. In the course of their journey these waves encounter numerous receiving antennae which gather in some of the energy of these waves and pass them on to the receiving set. When these radio waves are thus passed on to the receiver a number of different operations may be made. The waves may be *detected*, or they may first be amplified at radio frequency and then detected, and they may be amplified at audio frequency after being detected, and a combination of these three operations may be made. Each of these operations constitutes an essential part of the modern radio receiver and will, therefore, be taken up in this series. The first subject of importance to the beginner in radio is the matter of detection, since most novices will have detection sets before they have amplifying sets.

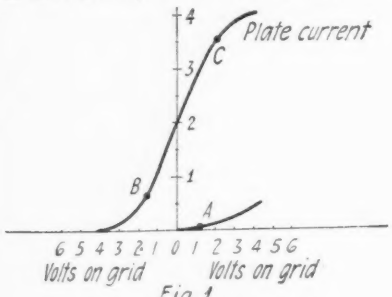


Fig. 1

Grid and Plate Current Characteristics of a Vacuum Tube.

When the radio wave from the broadcasting or other transmitting station passes down the receiving antenna and into the receiver, while it carries the speech or telegraph message, it is not in the proper condition to operate the headphones and thus convey the transmitted message. The reason for this is that the radio waves have a frequency which is too great to be heard in the telephones. Thus let us consider for a moment the wave which is sent out from some broadcasting station which transmits at 360 meters. The frequency of such a wave is approximately 800,000 cycles per second. Now, the very highest, vibration frequency which the human ear can hear is about 30,000 cycles per second; that is, if any object vibrates 30,000 times per second the human ear will just barely hear it. If it vibrates at a higher rate than 30,000 times per second, the human ear cannot hear or detect the sound. Imagine that the radio wave above mentioned has passed through the receiver and from there directly to the telephones. The current which would flow through the telephones would vibrate at the stupendously rapid rate of 800,000 times per second. If the diaphragm of the telephones could follow the current it would vibrate 800,000 times per second, but even if it did vibrate at this rate, the human ear would not be able to detect the signal, because of the natural limitations of the ear; it simply cannot hear such high frequencies. However, we have been somewhat optimistic in our supposition, for the diaphragm of a telephone receiver cannot possibly follow such rapid variations as 800,000 times per second, for its inertia is altogether too great to permit it to vibrate so rapidly. In the next place even if the diaphragm did follow these rapid vibrations no sound would be heard. For the radio currents flowing through the phones have a negative and a positive direction through the phones, thus their net effect on the diaphragm would be zero.

In order that the signal carried by the radio waves be made audible, it is necessary to transform these radio waves. For this purpose a detector is employed. Thus a detector is the device which so transforms the radio waves that they become audible in a pair of telephones. It will be evident that the name detector is really a misnomer. The detector does not detect or discover the radio wave. It is the antenna which brings in the radio waves. The detector, in effect, performs an operation on the incoming radio wave which permits us to hear the signals carried by it.

During the development of the art of radio a variety of detectors have appeared, among which may be mentioned the historically important ones of the coherer, the electrolytic detector, and the magnetic detector. These all served their purpose in the early stages of the game, but with developments and improvements they have had to give way to more efficient and sensitive detectors. Among the most efficient, most sensitive and most practicable are the two chief detectors of today, the crystal detector and the vacuum tube detector.

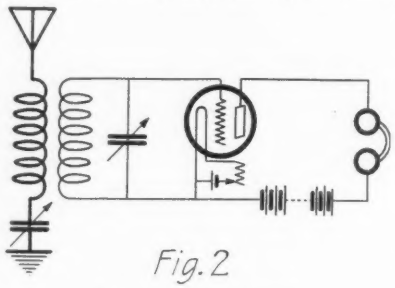


Fig. 2

A Radio Receiving Circuit

Although the crystal detector is also one of the older detectors of the art it serves a most useful function in present-day broadcast radiophone reception. It is one of the very simplest detectors, very sensitive, extremely easy to operate, and relatively inexpensive. It is also particularly suited to short distance or local broadcast receiving, and for local work is very frequently as good as the vacuum tube. In this article the theory and method of detection of the crystal receiver will not be given, as this subject has been excellently treated in RADIO NEWS before. The reader is recommended to study the article on "The Theory and Operation of Crystal Detectors" by Mr. Bonaventure in the April, 1923 issue, for details of this detector.

We will, however, take up the subject of the vacuum tube detector. This is the most recent type, and up to the present time is the last word in detectors. It is used where the most efficient and sensitive results are required and practically all long distance work is being done with this type of detector. It is, therefore, of interest to inquire how this device operates and what gives it its remarkable sensitivity.

CONDITIONS FOR DETECTION

Before going into the subject it is well to understand exactly what conditions a detector must fulfill in order that it make radio waves audible. In other words, what are the conditions of detection? As explained above, there are two main reasons why the radio current through the telephone receiver will not make the diaphragm move: First, the positive and negative halves of the radio cycle neutralize each other and hence will not influence the diaphragm; second the frequency of the radio current is above audibility. In order that we hear the signal in the radio wave the detector must then do at least these two things to the radio wave:

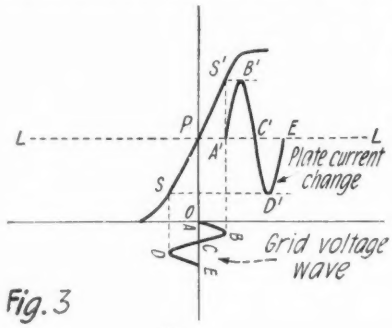


Fig. 3

Along Straight Part of Curve Equal Changes in Plate Current Are Produced by Equal Changes in Grid Voltage, Hence Positive and Negative Changes Neutralize.

1. It must cut off either the positive or negative half of the radio wave so that they do not neutralize each other in their effects on the telephone diaphragm, that is, THE DETECTOR MUST RECTIFY THE RADIO WAVE. This is the first condition for detection.

2. It must transform the radio frequency impulses of the radio wave into audio frequency impulses so that the ear can hear them. This is the second condition for detection.

We are now ready to consider the action of the vacuum tube detector and we will see in our discussion just how the above two conditions for detection are met.

There are two principal methods of detection employing the vacuum tube and these are: (1) plate circuit rectification and (2) grid circuit rectification. Both of these methods are based upon the shape which the characteristic curve of a vacuum tube has, namely on the curvature of the characteristic curve. Fig. 1 shows a typical characteristic curve of a three-element tube, which is obtained by applying different voltages to the grid and measuring the plate current corresponding to these voltages. It will be observed that at the beginning and end of the characteristic curve there is a

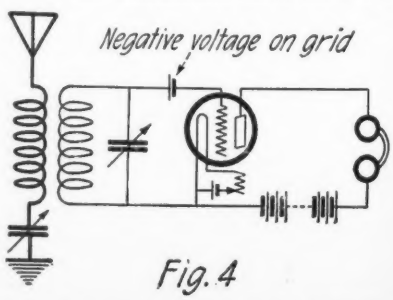


Fig. 4

A Radio Receiving Circuit in Which a Negative Voltage on the Grid is Employed for Purpose of Rectification.

marked curvature, while between points B and C the curve is a straight line, and the middle of this curve is approximately at zero grid potential. Suppose now that a radio frequency voltage is applied to the grid, let us say this voltage is due to a radio signal coming from the receiver in Fig. 2. This radio voltage is designated by the voltage wave ABCD (Fig. 3) which is one cycle of the wave. Now let us see what happens when this radio voltage is thus applied to the grid. When no signal voltage is applied to the grid, namely when it is at zero potential, the plate current is given by OP, and is constant as shown by the straight line LL. When the radio voltage ABCD is now applied, a change takes place. As the grid voltage rises from zero, i.e., point A, to its maximum positive value point B, the plate current also rises as seen from the characteristic curve, since a positive grid voltage produces a rise in plate current. The plate current thus rises from A^1 to B^1. As the grid voltage drops again to zero, i.e., point C, the plate current does likewise and drops to its normal constant value, namely C^1. The grid radio voltage now changes its direction and is negative and rises to its negative maximum value, namely to point D. From the characteristic curve we see that a negative grid voltage produces a drop in plate voltage. Hence the plate current now drops below its normal value to point D^1. When the grid radio voltage rises again to its zero value the plate current also rises to its normal constant value. Now it will be seen that since the changes in the plate current take place along the straight line part of the characteristic, namely between points SS^1, equal changes in grid voltage will produce equal changes in plate current. In other words, the average value of the plate current does not change, hence a telephone will not record any signal since it operates only when the average value of the plate current changes. We have here a case where the rises in plate current are the same as the drops in plate current, each thus neutralizing the other's effects on the telephone.

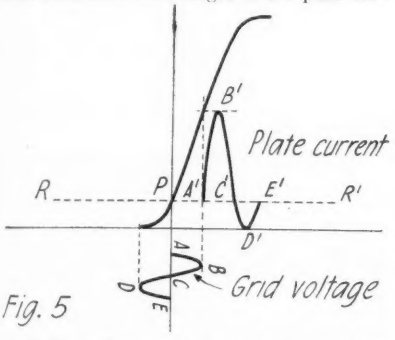


Fig. 5

At P, Where Curvature is Greatest, a Positive Grid Voltage Produces Greater Change in Plate Current Than an Equal Negative Voltage. Hence, Negative and Positive Halves Do Not Neutralize Each Other and Telephones Will Respond.

Suppose, however, that the circuit in Fig. 2 is changed to that of Fig. 4 by inserting a small battery in series with the grid, connecting the negative pole of the battery to the grid. Suppose that the value of this negative potential which is applied to the grid is one volt, and that again we have a radio signal voltage applied to the grid. The state of affairs is now much different and is represented by Fig. 5. Since the grid is permanently given a negative potential of 1 volt the zero axis is shifted over to the left by the amount of one volt, and the normal plate current is now lower than before and is given by RR^1. It will be seen that the characteristic curve intersects the plate current axis at the point where its curvature is a maximum. Suppose now that the grid radio voltage rises from A to its maximum positive B and then falls again to zero or C. The plate current will rise and fall proportionately, according to the characteristic curve; namely, it will rise to B^1 and fall to C^1. Now when the grid radio voltage swings to the negative cycle it goes to the same maximum, only negative and then comes back to zero. The plate current does likewise again following the characteristic curve, namely it falls to D^1 and then comes back to its normal value E^1. However, observe this important point: *On account of the curvature of the characteristic curve at P, equal grid voltages on positive and negative sides do not produce equal plate current changes.* Thus the positive grid voltage AB produces a greater change in plate current than the same negative voltage does. Hence, the negative changes do not neutralize the positive changes in plate current, as they did above, but since the positive change is greater than the negative change, there will be a change in the average plate current. In other words we have fulfilled the first condition for detection, namely we have rectified partially the plate current, since a greater change in plate current is produced in one direction than in the other.

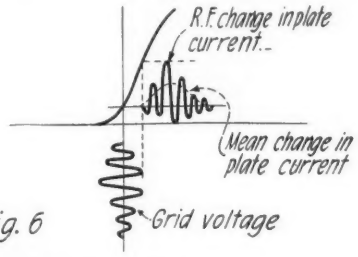
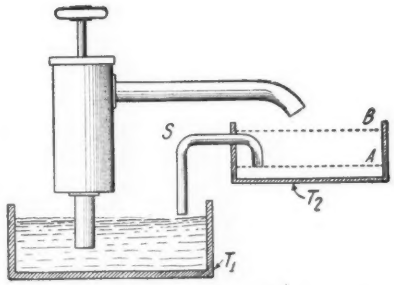


Fig. 6

Radio Frequency Changes in Plate Current Result in a Mean or Average Change of Plate Current Shown by Heavy Line. This Average Change Takes Place at an Audible Frequency.

Now let us see how the second condition is fulfilled, namely securing an audible effect from radio frequency changes. In order to understand this best, consider a radio wave applied to the grid which wave has varying amplitudes as in Fig. 6. The grid is again made negative by one volt, hence the axis is at minus one volt, Fig. 6. This is frequently called "biasing the grid potential." When the grid voltage varies according to the wave form shown, the plate current likewise varies, as explained above, only the increases are greater than the decreases. As we saw at the beginning of this article, the diaphragm of the telephone cannot follow the rapid radio changes in the plate current. However, since the increases in plate current at radio frequency are greater than the decreases, the average plate current will rise according to the shape shown in Fig. 6. This average change takes place at an audio frequency rate and hence will be recorded by the telephones, and a signal will be heard. It is thus seen that the second condition is met by a sort of integrated effect of all the radio frequency changes combining to produce one audio frequency change. For every wave this occurs and thus signals are heard. No matter what the shape of the incoming wave is, the above effects will be produced as explained.



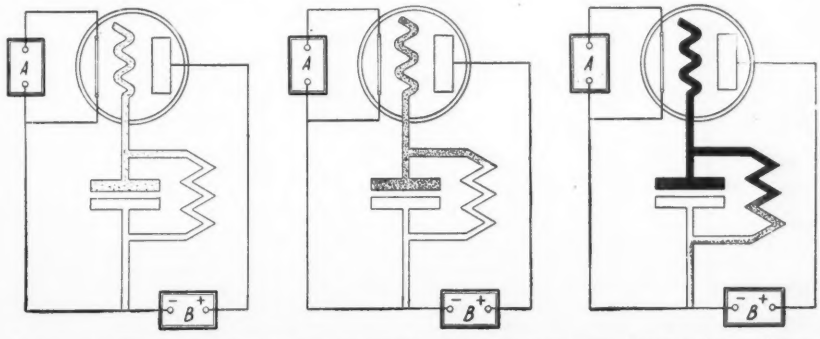
A Water Analogy of the Same Action as Mentioned Below. Each Action of the Pump (Incoming Wave) Goes Further Towards Filling Tank T-2 (Grid Condenser). When a Level B Above A is Reached the Water Will Flow Out Through Pipe S (Grid Leak) and Continue to Flow Until the Level A is Again Reached.

It will be observed that the rectifying action is really due to the fact that the characteristic curve is not symmetrical at the lower part, namely equal voltage variations on the grid do not produce equal plate current variations, but it will also be observed that the curve is likewise not symmetrical at the top. Hence, rectification should also be possible at that part of the curve, say by applying a positive potential of one volt to the grid. This is the case. However, detection never takes place at this part of the characteristic curve, for applying a positive potential to the grid causes a grid current to flow to the grid, which always results in high losses of power and hence very poor efficiency in detection. It is always best to use a negative potential on the grid for this purpose. This method is sometimes called "plate circuit rectification" because the current is rectified in the plate circuit.

The second method of detection is the so-called "grid circuit rectification" method so named because we now deal with the current flowing from grid to filament, which current is rectified. In the characteristic curve of Fig. 1 it will be observed that there is a small curve on the positive side of the current axis. This curve is the grid current characteristic, that is, it shows how the current in the grid circuit varies with the grid voltage. It will be observed that for negative grid voltages there is no grid current, while for positive grid voltages there is a small grid current. Just as the plate rectification method depends upon the curvature of the plate current characteristic, the grid circuit rectification method depends upon the curvature of the grid current characteristic. However, the difference between the two methods is the following:

1. While for plate circuit rectification we always use a negative voltage on the

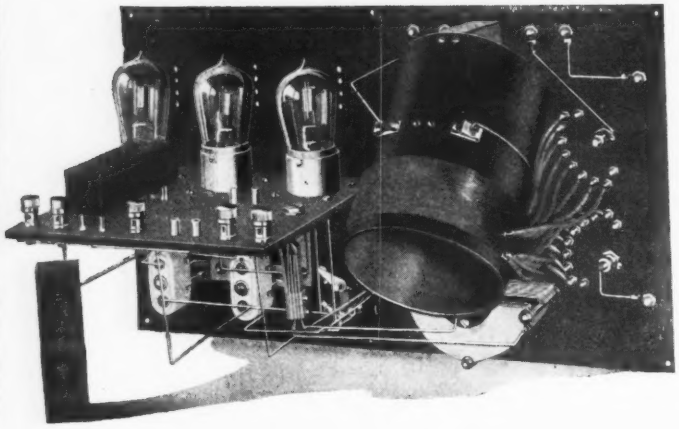
(*Continued on page* 201)



Representing What Takes Place in the Grid Circuit. Each Incoming Wave Goes Further to Charge the Grid Condenser. This Charge Increases Until it Reaches a Value That Will Allow It to Leak Off Through the Grid Leak.

Radio Frequency Receiver Design

By KENNETH HARKNESS*



A Rear View of the Two-Stage Radio Frequency Amplifier and Receiver Described in This Article. The Radio Frequency Transformers Are Mounted On the Same Base As the Tubes and Directly Behind Them. A Variocoupler, Together With a Variable Condenser, Is Used For Tuning Purposes.

THE manifold advantages of radio frequency amplification are becoming more and more evident to radio experimenters. For some strange reason this most useful application to radio of the amplifying characteristics of the audion has met with considerable skepticism among amateurs in the United States, and there are still a great number who consider it impracticable. Some time ago the well-known editor of a weekly newspaper radio department invariably informed his inquirers that radio frequency amplification was quite useless below 1,000 meters and it is only quite recently that he has been made to realize he was in error. We were also greatly surprised to see, not long ago, a statement made by the editor of a radio magazine that radio frequency amplification on 200 meters was practically impossible.

Both these editors, who should have known better, and the skeptics among radio amateurs themselves, were evidently under the impression that no progress has been made in radio frequency amplification since the development of the "resistance-coupled" and the "tuned-impedance" amplifiers. Without going into the details of these two methods of radio frequency amplification, we are quite prepared to admit that the first is useless for 200-meter reception and of little use below 1,000 meters, while the second, although fairly efficient on short waves, is too complicated to tune, and limits the number of stages of amplification.

Both these methods of reception have been superceded by transformer-coupled amplification. The design of an efficient radio frequency transformer is no simple matter. It is not our object in this article, however, to discuss the merits and de-merits of various existing types of transformers. We merely wish to affirm the fact that a few of those on the market are actually efficient and positively provide the solution of the difficulty experienced in amplifying the high frequencies of short waves.

SHORT WAVE R. F. AMPLIFICATION DIFFICULT

The great obstacle to the amplification of short waves has been the presence of capacity in the circuits which practically acts as a short-circuit to extremely high frequencies. In the transformer-coupled system of amplification there is capacity between the elements of the vacuum tube, capacity in the wiring between the tubes and transformers, capacity in the transformer windings and between the primary and secondary windings of the transformer. If any of these values exceed a certain degree it is impossible to amplify short waves efficiently.

The capacity between the elements of the vacuum tube is, of course, fixed by the manufacturer of the tube. There are, however, different types of tubes and invariably the tube with the least internal capacity is the most efficient for radio frequency amplification.

The capacities of the transformer windings and between the primary and secondary windings of the transformer are also fixed by the manufacturer of the transformer.

Therefore, to obtain good results in the amplification at radio frequency of short waves, the amateur will realize the importance of a vacuum tube with low internal capacity and a transformer with low capacity in its windings and between its two windings. It is possible to obtain such vacuum tubes and transformers. The late A.P. amplifier tube was of this type and very efficient for radio frequency work. The new de Forest tube is also very suitable. The latter tube is somewhat similar to the French amplifying tube which is unusually good for amplifying high frequencies.

WIRING IS IMPORTANT

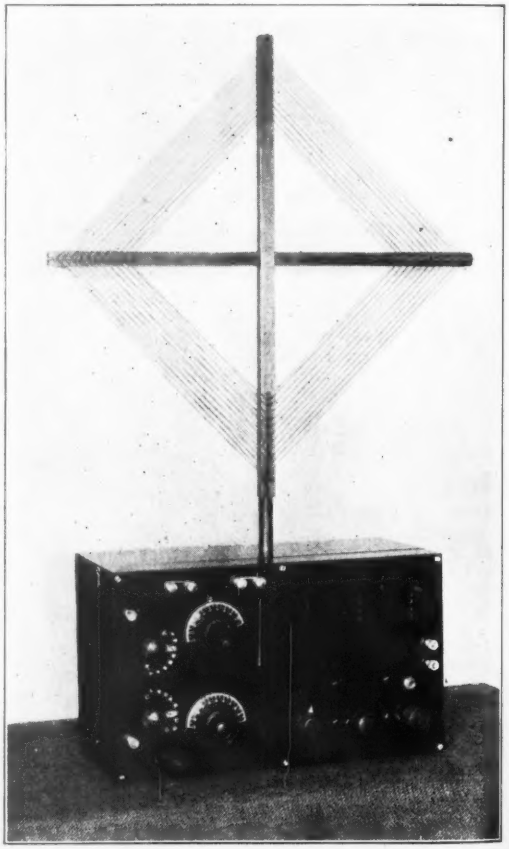
Thus, if the experimenter makes a proper choice of vacuum tubes and radio frequency transformers, it only remains for him to wire his receiver properly to avoid capacity effects in the wiring connecting together the transformers and vacuum tubes.

It is the purpose of this article to indicate a design of radio frequency receiver which accomplishes this object. The receiver shown in the accompanying photographs is designed to amplify efficiently wave-lengths as low as 200 meters and the apparatus is arranged in such a manner that wiring between the transformers and tube sockets may be kept exceedingly short to avoid loss of efficiency by capacity. Of these leads, the most important are those connecting the secondaries of the radio frequency transformers to the grids of the succeeding tubes. Next in importance are the plate leads, which should be as short as possible and widely spaced from the grid leads; the length of the other leads is not so important.

If reference is made to the back view photographs shown herewith, the general design of this receiver will be evident. The radio frequency transformers are plugged into sockets on the top of the shelf panel and these sockets are so arranged that the length of the wires connecting the transformer secondaries to the grids of the tubes are not more than one inch in each case. The plate leads are slightly longer but widely spaced from the grid leads.

NEW FEATURES IMPROVE FLEXIBILITY

There are other features in the design of this receiver which greatly increase its usefulness as well as its efficiency. A telephone jack is attached to the shelf panel so that a small loop aerial may be inserted through the cover of the cabinet, as shown below. In this way the loop may be conveniently revolved in any direction. The wiring diagram of the receiver, shows the manner of wiring to this jack. When the loop is plugged in, it takes the place of the secondary circuit of the tuner, which is opened. The secondary tuning condenser is used to vary the wave-length of the loop circuit. This condenser is provided with a vernier plate which greatly assists in fine tuning. The remainder of the circuit consists of two stages of radio frequency amplification and detector.



This Shows the Completed Radio Frequency Receiver. The Two Knobs and Dials Are Used for Tuning Purposes. The Small Knob in the Center Controls the Potentiometer, While the Other Two Are the Rheostat Controls.

*Chief Engineer, The Radio Guild.

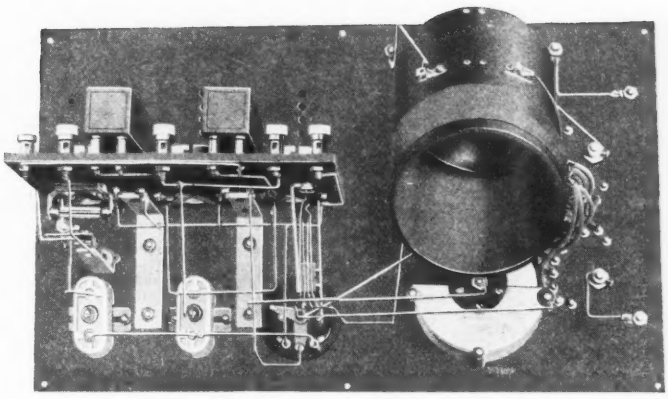
The voltage on the grids of the two amplifying tubes is controlled by a potentiometer across the filament battery and by means of this voltage-divider a slight positive bias may be placed on the grids of the amplifying tubes to prevent oscillations in the circuits.

The output circuit is provided with a double-circuit jack so that the telephones may be plugged in the detector plate circuit and the output connected to an audio-frequency amplifier, if loud signals are desired.

The battery terminals are attached to the rear of the shelf panel so that the connections from the batteries may be brought through the back of the cabinet.

When the loop is removed from its jack, the secondary inductance, which consists of the rotor of a special vario-coupler, automatically takes its place in the circuit and extreme long distance reception can then be effected with an outside aerial and ground connected to the primary circuit of the vario-coupler.

However, with the ordinary type of vario-coupler, this would result in a great loss of selectivity. In fact, tests have proven that the ordinary type of vario-coupler in which the secondary revolves inside the primary is practically useless when succeeded by radio frequency amplification. This arrangement is only slightly more selective than the direct-coupled circuit.



Another Rear View of the Same Receiver. The Two Rheostats Can Be Seen on the Left of the Panel Followed by the Potentiometer and the Variable Condenser.

SPECIAL COUPLER USED

The receiver illustrated employs a special type of coupler which is intended for use only with radio frequency amplification. This coupler was designed by the writer as the result of experiments which proved that the degree of coupling in the ordinary type of vario-coupler could not be made loose enough for the tuner of a radio frequency amplifying receiver. Although the mutual inductance was exceedingly small at the minimum degree of coupling, the physical location of the secondary coil with respect to the primary provided a capacity coupling which, although it would not be disadvantageous in ordinary circuits, nevertheless afforded a sufficient coupling to result in a considerable loss in selectivity when followed by radio frequency amplification. It should be realized that if the sensitivity of a receiver is increased, interference will also be increased unless the receiver is made more selective.

The special type of coupler employed in this receiver is shown in the photograph. The primary coil is wound on the lower end of a long cylindrical form, while the secondary is wound on a smaller coil which revolves inside the primary form at the opposite end. The rotor shaft is set at an angle to permit a 180-degree variation of coupling. This feature permits a very fine adjustment of the coupling.

When the coupling is at a maximum, that is to say when the rotor is in such a position that there is maximum inductive relation between the primary and secondary coils, the secondary coil is separated from the primary by a spacing of 1½" or, from center to center, of 4". Thus there is at no time any appreciable capacity coupling between the primary and secondary circuits, although when the coils are in the position just described there is a certain value of mutual inductance between them. This degree of inductive coupling is not large, but the coupling is sufficiently close when succeeded by radio frequency amplification. It can be still further decreased by revolving the secondary rotor until the two coils are at right angles to each other when the coupling is at a very low minimum.

Experiments have shown that the minimum and maximum degrees of coupling obtainable in this unit provide the proper variation of coupling for selectivity in a radio frequency receiver. Although the coupling is very loose and would result in a loss of signal strength in an ordinary circuit, it is intended only for use with radio frequency amplifying circuits which enormously magnify the incoming oscillations transferred by the coupler from the primary to the secondary coil. It is, therefore, possible to use this extremely loose coupling without any loss, but instead a considerable gain in efficiency, as this loose coupling makes possible a high degree of selectivity.

ANTENNA CIRCUIT RESISTANCE IS DETRIMENTAL

In explanation of the reason for this selectivity it will be understood that the antenna circuit, because of its size and decrement, cannot be accurately tuned to any particular frequency without being subject to forced oscillations of different frequencies. Static and atmospheric strays, as well as radio waves of varying frequencies all produce forced oscillations in the antenna irrespective of the wave-length to which it is tuned, although oscillations of the latter frequency will persist longer and reach a greater amplitude than the others, since the circuit is approximately resonant at this frequency.

If the secondary circuit is closely coupled to the antenna, as in the standard type of coupler, these undesirable oscillations caused by interfering signals, static and atmospheric strays, will be transferred to the secondary circuit and will interefere with reception. In a crystal receiver or straight audion hook-up, a fairly close coupling is required in order to efficiently transfer the energy from the primary to the secondary circuit. Consequently interference is more marked in these circuits.

The regenerative circuit permits a loose coupling between the antenna and secondary circuits because the energy in the secondary circuit is amplified by regeneration. As the energy in the secondary circuit is increased by regeneration, the reaction between the two circuits is also increased so that some of the energy in the secondary circuit is retransferred to the antenna circuit. To maintain resonance, the coupling must be decreased. This decrease of coupling, of course, results in an increase in selectivity as the looser coupling prevents to a greater extent the transfer to the secondary circuit of forced oscillations of undesired frequencies in the antenna circuit.

Now, whereas the amplification of energy by regeneration may reach a certain fixed value, the amplification by radio frequency amplification is greatly in excess of this value when several stages are used. While it is true, then, that regenerative amplification permits a looser coupling than a straight audion hook-up or crystal receiver, it will be evident that radio frequency amplification permits a still looser coupling than the regenerative receiver, and a corresponding increase in selectivity is obtained.

By reason of its proper design, the receiver illustrated in the photographs is a witness to the many advantages which radio frequency amplification affords.

LONG RANGE OBTAINED

With this receiver, without loop, antenna, ground or any outside connection whatsoever, we have personally received signals from transmitting stations within a radius of two hundred miles. The "antenna" consisted of the rotor of the vario-coupler, 3" in diameter. With the small loop aerial inserted through the cover of the cabinet and plugged in the jack on the shelf panel, distances of over one thousand miles have been covered with great regularity. The advantages of loop reception are well known—selectivity, directional reception and freedom from static interference. With an outside aerial there is no loss in selectivity because of the special type of coupler, but there is a considerable increase in receiving range.

Although every possible control is included in the receiver, the tuning is not complicated. When receiving with the loop there are only two controls, the secondary tuning condenser and the potentiometer—simplicity itself. When using an outside antenna, the antenna circuit is tuned by two switch sets tapping the primary coil, one controlling multiple turns and the other single turns. The coupling between the circuits is controlled by the rotor of the vario-coupler,

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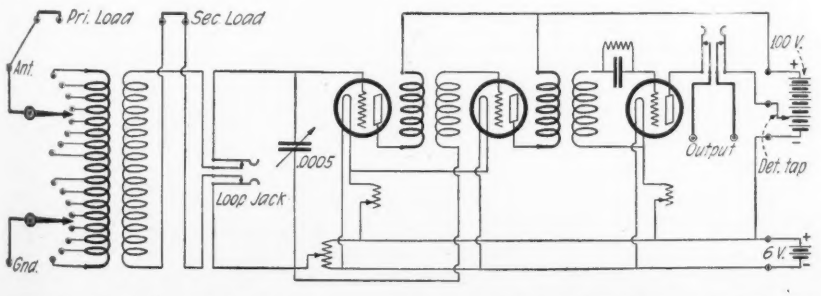
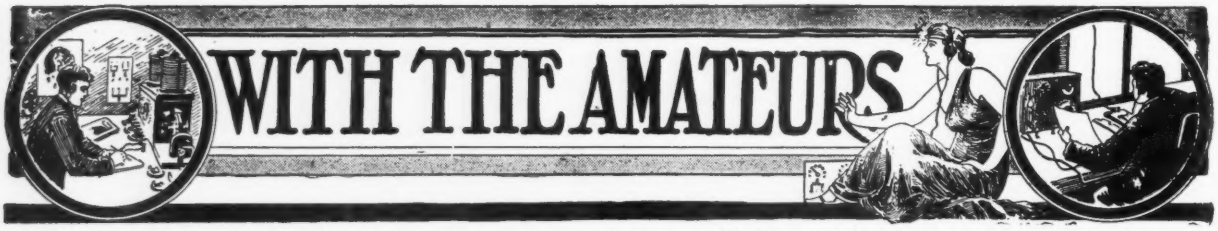


Complete Circuit Diagram of the Radio Frequency Receiver. The First Two Tubes are the Radio Frequency Amplifiers, the Third Being Used for Detection. When a Loop Aerial is Used it is Plugged into the Loop Jack. This Jack is Mounted in the Top of the Cabinet so that the Loop can be Plugged in or Taken Out at Will. When the Loop is in Position the Variocoupler is Automatically Disconnected.



THIS Department is open to all readers. It matters not whether subscribers or not. All photos are judged for best arrangement and efficiency of the apparatus, neatness of connections and general appearance. In order to increase the interest in this department, we prefer to publish photographs of stations accompanied by a picture of the owner.

We prefer dark photos to light ones. The prize winning pictures must be on prints not smaller than 5 x 7". We cannot reproduce pictures smaller than 3½ x 3½". All pictures must bear name and address written in ink on the back. A letter of not less than 100 words giving full description of the station, aerial equipment, etc., must accompany the pictures.

PRIZES: One first monthly prize of $5.00. All other pictures will be paid for at the rate of $2.00 each.

2FZ, Second Prize Winner In Hoover Cup Contest

Owned by FRANK FRIMERMAN

This Month's Prize Winner

Mr. Frimerman Seated In Front of His Transmitter. The Three 50-Watters Are Conspicuous, As All 50-Watt Bottles Are. Note the Large Chopper Directly Behind the Microphone, and the Huge Variable Condenser To the Right Of It.

SITUATED in the heart of The Bronx, Station 2FZ, owned and operated by Mr. Frank Frimerman, 740 Prospect Avenue, New York City, is the solar system for the bulk of New York A.R.R.L. traffic. Although surrounded by numerous large steel structures, which tend to absorb radio energy, Mr. Frimerman has overcome this obstacle by bringing his transmitting and receiving systems up to the highest peak of efficiency. 2FZ is one of the few real DX stations on the East coast. For this reason it is selected by the majority as a reliable medium for the relaying of long-distance traffic.

The interior of Mr. Frimerman's station is a "sight for sore eyes." Very few commercial companies can boast of better installation or a more convenient disposition of apparatus and remote control system than here. There are so many unusual features and worth-while pointers relative to 2FZ that justice can be done only by a complete description.

THE ANTENNA SYSTEMS

The transmitting antenna is a 24" cage of the "T" type, consisting of six 7-strand No. 14 phosper-bronze wires, 70' long and 75' from the ground. A six-wire cage lead-in runs directly to a heavy duty lightning switch, mounted on the outside of the house. A 12-wire fan-type counterpoise, 40' long and 10' from the ground, runs directly under the transmitting antenna. This is connected to the oscillation transformer by heavy cable.

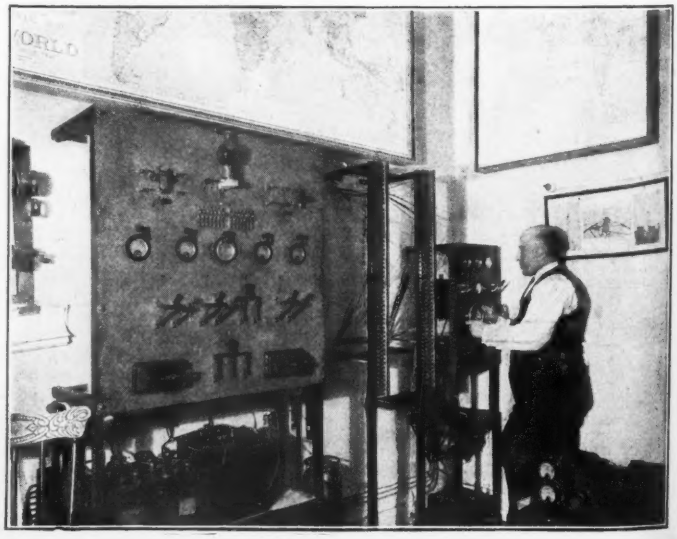
The receiving aerial consists of one 7-strand No. 14 phospher-bronze wire, 600' long and 75' high. This runs at right angles to the transmitting antenna and connects to a separate switch outside of the house. The receiving ground is made to a water-pipe.

THE TRANSMITTER

The transmitter of 2FZ uses the Hartley circuit. Three 50-watt tubes are employed and are arranged so that they can be connected in the following combinations: For phone transmission, one oscillator, one modulator and one speech amplifier. For buzzer modulated C. W., two oscillators and one modulator. For pure C. W., three oscillators. A chopper, run by a synchronous motor, can be connected in the circuit for I. C. W. The plate supply is generated by a 1000-volt D. C. Esco motor-generator. Alternating current is employed for the filament supply and is obtained from a 300-watt Acme transformer. Directly above the tubes are four meters, designating plate voltage, plate amperage, grid current and the radiation in amperes. The radiation ammeter is of the thermo-couple type. An electric fan is provided for keeping the tubes cool while in operation.

THE RECEIVING SETS

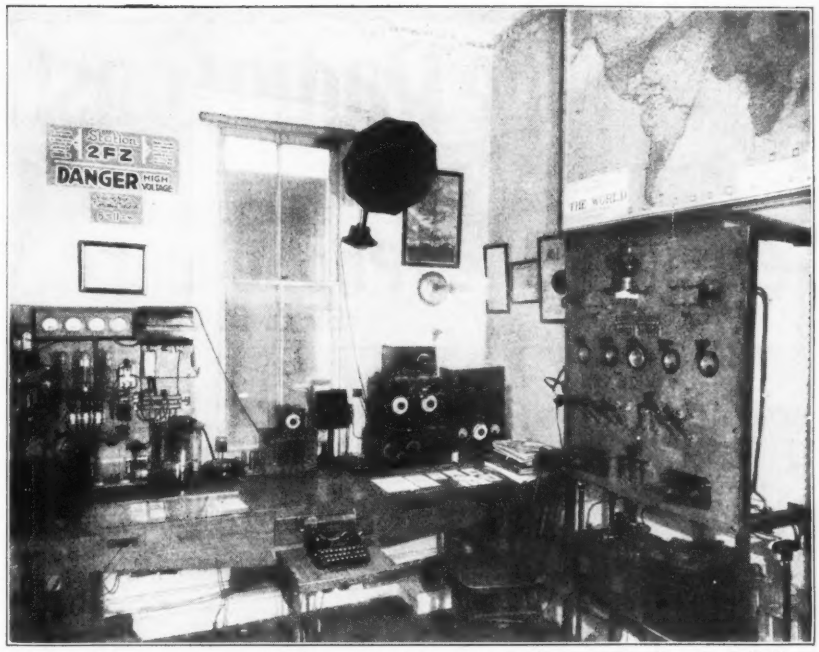
Mr. Frimerman has two receiving sets; one which is used for amateur work and the other for the reception of broadcasting and long-wave stations. The set which is used for the reception of amateur signals is of the Reinartz type, employing two variable condensers and a spiderweb coil. One stage of audio frequency amplification is included within the same cabinet,



A General View of the Power-Control Panel, Connecting Rack and the Panel That Controls the "B" Voltage For the Vacuum Tubes of the Receiving and Amplifying Units. The Esco Motor-Generator, Which Supplies the Plate Voltage For the Transmitting Tubes, Can Be Seen Directly Behind Mr. Frimerman.

this being all that is usually necessary. The other receiver is of the honeycomb type, employing primary, secondary and tickler coil with the usual series and shunt variable condensers. This receiver is mounted directly on top of the Reinartz tuner. To the right of this, and mounted on porcelain insulators, is the detector and two-stage audio frequency amplifier unit employed with the last mentioned set. A separate one-stage audio frequency amplifier is included for use when great volume is desired. This unit can be connected in cascade with either of the receiving sets. Directly underneath the large map of the world in the photograph may be seen the main control and charging panel. This includes at its top a Tungar rectifier bulb, for use in charging the two 6-volt storage batteries which are used for supplying the current for the filaments of the detector and amplifier tubes in the receiving sets, and the 12-volt storage battery that is used primarily for supplying the current for operating the relays and small lights which make up the remote control system, which is to be described later. Directly under the Tungar rectifier bulb is the fuse rack; these fuses being connected in the circuits of the motor-generator, receiving vacuum tubes, and the filaments of the large transmitting tubes. Should one of these fuses blow, a small red light immediately glows. The closing of any switch upon the panel lights a small lamp.

Meters for the reading of charge and discharge amperes, "A" and "B" battery voltage, and the current consumed by the functioning of the remote control system, are immediately below the fuse rack. At the lower part of the panel are two relays; the one to the left makes and breaks the circuit of the Esco motor-generator, and the one to the right makes and breaks the circuit of the small charging generator. "B" voltage for the tubes in the receiving sets is obtained either from block "B" batteries or from two small Signal-Corps type motor-generators. This circuit is controlled by a small panel to the right of the connecting rack; this includes two rheostats for the control of the "B" voltage produced by the generators. The connecting rack itself, which is between the two control panels, is the most unusual feature, and 2FZ is probably the only station that employs one. All connections of the remote control system, as well as those from the control panel, receiving set and transmitting set, are run to this rack, where it is possible to change an entire circuit or strap over from one circuit to another.



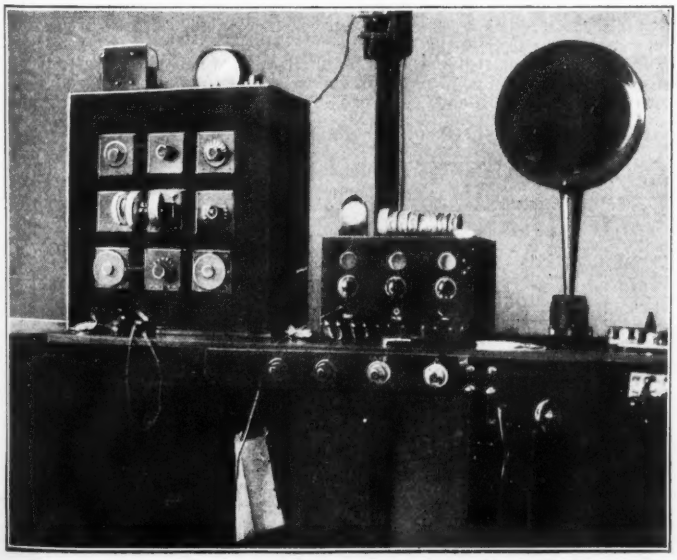
This Photo Shows the Transmitting Set and Receiving Units Particularly Well. The Small Cabinet in the Center of the Table is the Termination of the Remote Control System. All Operations Can Be Controlled From This Center.

THE REMOTE CONTROL SYSTEM

Directly in the center of the operating table is the heart of the remote control system. By means of cam switches and plugs and jacks, any operation in any part of the room can be started or stopped at will. By inserting a plug in a definite jack the aforementioned combinations of the transmitting tube connections are instantly made and by throwing a cam switch the tubes light up, the electric fan starts and the relay on the control panel closes the circuit of the motor-generator supplying the plate voltage. Changing from one receiver to another and connecting the separate amplifier into either receiver, are as well accomplished from this small cabinet in front of the operator.

Of special interest are the maps upon the wall. The large map of the United States, which unfortunately cannot be seen in these photographs, has upon it small lights of different colors, designating the locations of the principal ship-to-shore, trans-oceanic and broadcasting stations. The principal amateur stations with which 2FZ runs regular schedules are also designated by small lights. Large lights with numbers printed upon them show the location of each and every radio district in the United States. This rather unique arrangement is also controlled from the small cabinet in the center of the operating table.

Mr. Frimerman has spent many years in bringing this station up to its present point of development. All of the work was done by himself and it is to be understood that no radio engineers or electricians participated in either the design or the installation of this station. All of the wiring, a good deal of which runs underneath the tiled floor, was made by Mr. Frimerman. There is little wonder that Station 2FZ was one of the winners in the Hoover Cup Contest.



A View of Mr. Jordan's Station. This Was But Recently Licensed and Has Received the Call Letters 9ALI. A 5-Watt S.P.C.W. Transmitter Is Employed, But Is To Be Replaced By a 10-Watt C.W. I.C.W. and Phone Set.

Roy Jordan's Station
Wyeville, Wis.

THE following is a description of my station, together with a general view of the apparatus. The main antenna is a "T" type cage, 80′ long, consisting of five wires, equally spaced around hickory hoops 18″ in diameter. A four-wire cage lead-in drops from the center of the main span. The antenna is held aloft by two built-up wooden masts, each 80′ high. These masts taper from 8″ square at the bottom, to 4″ square at the top, and are securely guyed in all directions. Directly under the main span, and about 8′ from the ground, I have a counterpoise, of the same dimensions, which at present is being used in connection with various reception tests. A single wire, 150′ long and 20′ high, as well as two small loop aerials, are also available for testing.

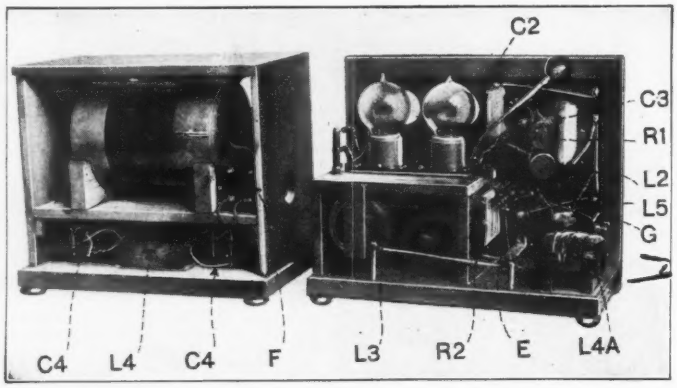
My receiver consists of de Forest panels. This receiver is of the three-circuit type, using honeycomb coils for primary, secondary and tickler. Two large de Forest Vernier variable condensers are employed, one being connected across the primary coil, and the other across the secondary. A three-stage audio frequency amplifier, using R.C.A. transformers, is mounted in the smaller cabinet, to the right of the receiver proper. Both receiving and amplifying instruments are entirely home-designed and assembled. An R-3 Magnavox is used when

(*Continued on page 225*)

The Radio Constructor

A Low Power Phone and C. W. Transmitter

By D. R. CLEMONS*



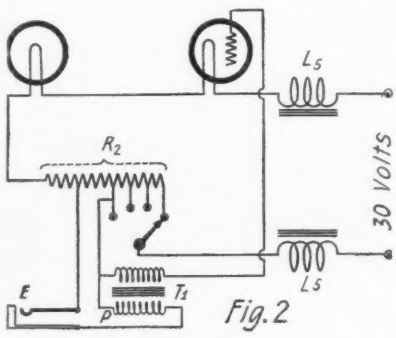
A Rear View of the Transmitter, Showing the Two Vacuum Tubes and the Power Unit Which Houses a 350-Volt Dynamotor.

PARTS necessary for a radio telephone or continuous wave telegraph set are shown in the illustrations. An instrument was desired for speech or code transmission and also to be applicable as a generator of high frequency oscillations for laboratory measurements, hence filament, grid and plate terminals are provided for employing any desired oscillatory system. Finally, the outfit was to be set up as cheaply as possible, therefore, nearly everything in it is original.

Fig. 1 is a lettered diagram showing a Colpitts oscillatory system having separate modulator tube and auxiliaries. Filaments of two 5-watt Western Electric power tubes form a series circuit through a 12-ohm resistance, R_2, retarding coils L_5 and 30 volts of storage battery. A 30- to 350-volt dynamotor supplies plate potential through a filter, fuses at F and G and the large inductance L_4A. A potential of several volts for microphone or buzzer is obtained by shunting a portion of R_2, buzzer or microphone being plugged in at jack E. A grid bias voltage of —15 is also provided by this method. To use both tubes in parallel for straight C. W., or for laboratory use as a plain oscillator, the link at X is opened and grids are connected together by shunt A, the plates being connected by shunt B, which must bridge reactance coil L_3. In such cases a variable grid leak is adjusted.

FILAMENT CIRCUIT FOR 30 VOLTS (W. E. TUBES)

Fig. 2. This arrangement is very good and is possible when the phone is used on farm lighting circuits, or where 30-volt dynamotors are employed for plate potential. Both tubes should be of similar type and characteristics. Western Electric 5-watt tubes require seven filament volts, so two in series require 15 volts. Since such tubes require 1.35 amperes, a resistance R_2 of 12 ohms establishes a drop of the remaining 15 volts. Coils L_5 are iron cored, low resistance impedances for reducing motor commutator surges entering the filament circuit from the battery. Since a —15-volt drop exists across the oscillator tube and resistance R_2, a proper negative voltage may be placed on the modulator tube grid by attaching the lower secondary terminal of modulation transformer to some point on R_2. This is necessary if



Circuit Arrangement Used for Obtaining the Filament Supply from a Farm Lighting-Plant.

the tube is to function along a straight portion of its curve, otherwise bad distortion would result. The exact voltage required will depend partly upon the plate voltage and should be found by test; however, about 6 ohms of R_2 will be required for a plate voltage of 350. Resistor R_2 is sketched in Fig. 9 and is tapped at 6, 8, 10 and 12 ohms for filament adjustment by switch S_1. Transformer primary T_1 includes jack E and 4 ohms of resistance in R_2, thus giving 5 volts for the microphone or buzzer.

FILAMENT CIRCUIT FOR RADIOTRON 202

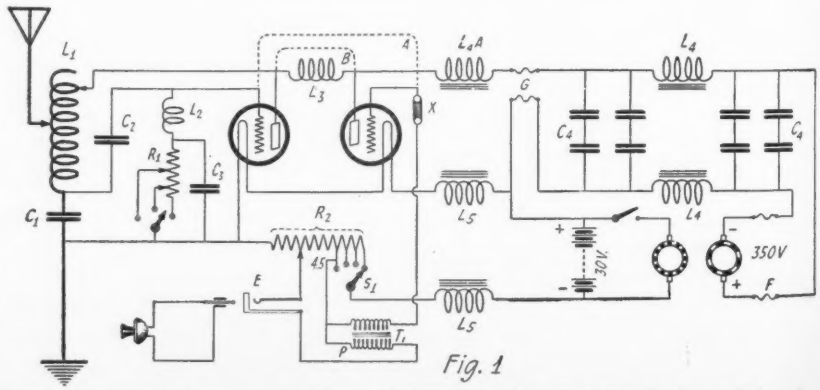
Fig. 2. Radiotrons require 7.5 filament volts at 2.35 amperes, hence the arrangement would be similar as shown in Figs. 1 and 2 except that R_2 should be of Nicrome 22, wound as shown in Fig. 9. This gauge averages 1 ohm per foot, so 12 feet would be required.

FILAMENT CIRCUIT FOR 12-VOLT SUPPLY (UV-202 OR W. E. TUBES)

Fig. 3. If only 12 volts were available, as might be the case where plate voltage is obtained from an independent source, both tubes would be in parallel, as in Fig. 3. Since a 5-volt external drop would be necessary, two 5-ohm rheostats having 3-ampere capacity would be included in each filament. This arrangement would provide sufficient microphone or buzzer potential, but the grid bias voltage on the modulator may be too low, requiring a "C" battery of several volts with its negative side to the grid. Such a battery would be included in the grid circuit in series with the transformer secondary. Either UV-202 or W. E. 5-watt tubes may be employed.

MOTOR GENERATOR AND FILTER

A Westinghouse dynamotor operating directly from a 30-volt storage battery gives a plate voltage of 350 at .08 ampere. A felt-lined cradle supports the dynamotor within a separate cabinet, the filter system being built into the base, making a very satisfactory arrangement. A constant plate voltage is desirable in radiophone equipment, but even well designed dynamos possess a slight potential difference between segments which, as they come rapidly into position under the brushes successively, cause a rise and fall of potential amounting to several volts. This change produced several hundred times in one second passes on to the plate circuits



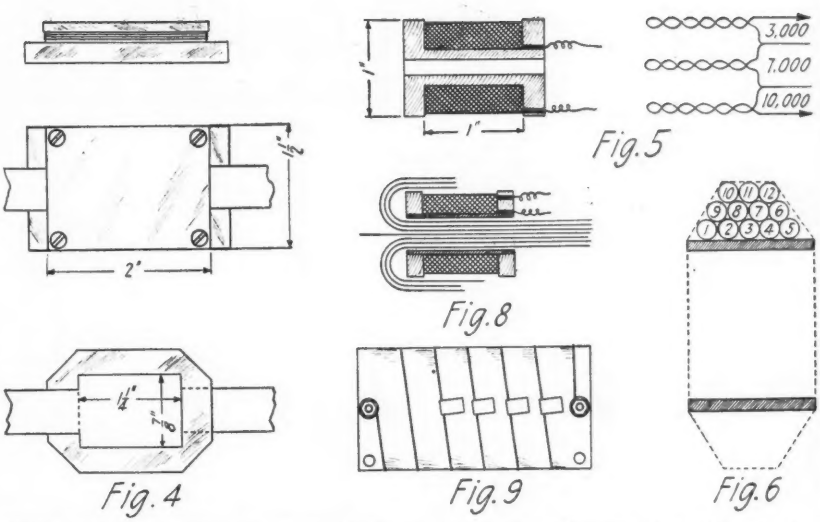
The Complete Circuit Diagram of the Phone and C.W. Transmitter, Including the Power Unit and Filter System. The Two Tubes Can Be Used in Parallel for C.W. by Opening Link "X" and Connecting the Grids and Plates Together by Shunts "A" and "B."

*Radio Instructor, Dodge's Radio Institute.

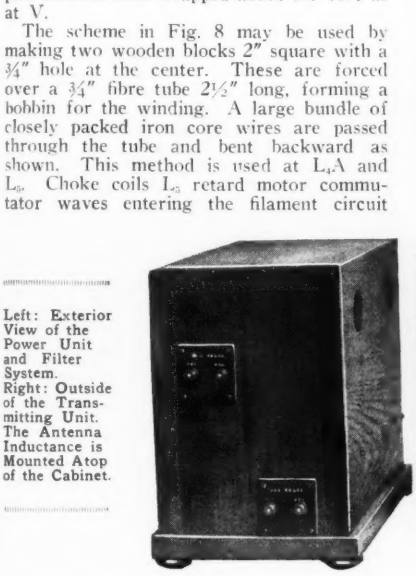
as "*commutator ripples*" resulting in tonic variations of amplitude of the transmitted energy. As a result of "*ripples*" a disagreeable noise is heard in a receiver and speech is also of relatively poor quality, particularly at harmonic tone frequencies. Since slight variations are not overcome in generator design, it is necessary to reduce such currents to a much steadier condition by filtering. Such a filter system is mounted within the generator cabinet shown and consists of two 1¼-henry inductances L_4 with eight 1-microfarad condensers C_4 connected as shown in Fig. 1. Since economy may begin here, paper telephone condensers of 1 mfd. each may be safely used if first tested carefully, as, say, on 220 volts A. C. Such condensers are obtainable from telephone salvaging stores. Chokes L_4 are constructed as shown in Fig. 7, although they may be built as shown in Fig. 8, which is of much simpler construction. In Fig. 7 a soft iron bar ¾" in diameter is cut 2½" long and is drilled and tapped for 8-32 machine screws at each end. Several layers of Empire cloth are wrapped about the core, then 1,500 turns of No. 28 insulated copper with flexible terminals are wound into layers 2" long. The winding is covered with Empire cloth. The magnetic circuit is completed through two half rectangles of laminated core-steel shaped to enclose the winding, the ends join at Y and are clamped by screw S, where several discs of mica form an air gap between the core and ends Y of Fig. 7. Empire cloth is then wrapped about the core as at V.

The scheme in Fig. 8 may be used by making two wooden blocks 2" square with a ¾" hole at the center. These are forced over a ¾" fibre tube 2½" long, forming a bobbin for the winding. A large bundle of closely packed iron core wires are passed through the tube and bent backward as shown. This method is used at L_4A and L_6. Choke coils L_5 retard motor commutator waves entering the filament circuit from the battery. Each is 100 turns of No. 14 enameled wire built up as in Fig. 8, except that wooden end pieces are not used. Modulation inductance L_4A is a large inductance coil of low ohmic resistance, to hold the plate potential quite steady while potentials of the modulator are changing. It contains 1,800 turns of No. 28 copper wire, built up as in Fig. 8.

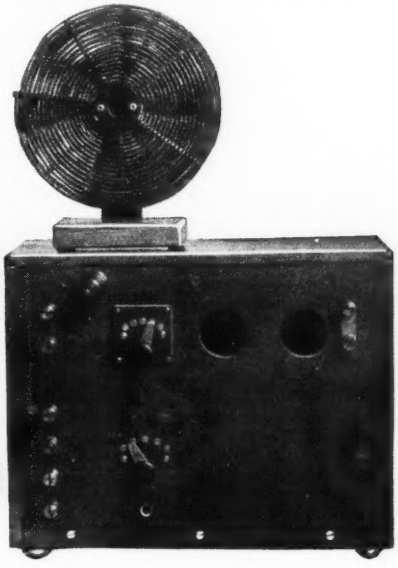
Since 75 milliamperes of current move in coils L_4 and L_4A, their direct current resistance must be low to prevent a large potential drop within them. If too fine wire were used, say 40, a drop of about 24 volts per coil would make a total drop of 75 volts, reducing the plate-filament voltage to 275. In L_4 and L_4A the total resistance is 135 ohms, which causes a drop of 10 volts only, allowing 340 on the plate.

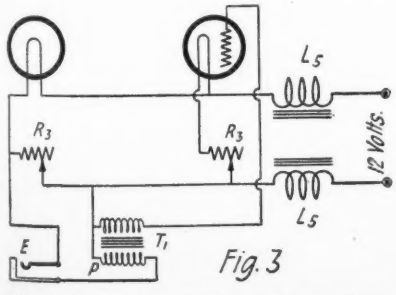


Design Data for the Construction of the Condensers, Chokes and Resistances Which Make Up the Filter System of the Power Supply Unit.



Left: Exterior View of the Power Unit and Filter System. Right: Outside of the Transmitting Unit. The Antenna Inductance is Mounted Atop of the Cabinet.





When Using an External Filament Supply of Not Over 12 Volts, the Filaments Are Connected in Parallel.

HIGH FREQUENCY CHOKE L_3

This is a layer wound inductance of 3 millihenries wound up as shown in Fig. 6; 100 turns of No. 26 cotton on a 2" tube. This coil keeps high frequencies from entering the modulator tube. Against radio frequency potentials it presents 28,000 ohms reactance; but for voice frequencies from the modulator tube only several ohms are present, which is partly copper resistance, hence a relatively coarse wire should be employed here. Antenna coil L_1 is a spiral coil of 36 turns of No. 16 double cotton covered, wound upon a wooden frame of radial wooden pins. Several tabs are soldered to the coil, which is of 145 microhenries, clips being provided for adjustment.

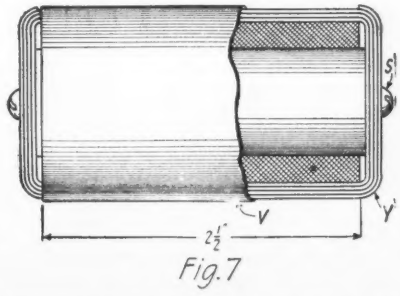
CONDENSERS C1, C2 AND GRID CONDENSERS

All these are made similarly as shown in Fig. 4, where two small strips of bakelite are cut and drilled to form a clamp for the mica condenser. Each condenser is adjusted for a capacity of .0005 mfd., by cutting two copperfoil strips 1¼" by ⅞", with a projecting end for connection as shown. These strips are separated by several mica sheets of about .003" when compressed. These capacities may be approximated since none are critical.

Inductance L_2 is a small coil of 3 millihenries wound upon a wooden bobbin shown in sketch No. 5. About 350 turns of No. 26 cotton covered wire will be required. Likewise, the grid leak R_1 is a bifilar wirewound resistance unit tapped for 3,000, 7,000 and 10,000 ohms. A section of 38 manganin resistance wire is cut to length and doubled, the bight being first wound upon the spool, allowing both parallel wires to be wound in at the same time, making the unit quite noninductive. Since such wound resistors have capacity predominating, C_3 may not be required, but it should be used if vitro-enamel resistors are employed as leaks.

Filament resistor R_2 is wound upon a thin strip of bakelite as shown in Fig. 9. Twelve feet of No. 22 Nicrome is tapped at 6, 8, 10 and 12 ohms by soldering in copper tabs after winding onto the frame. Five ohms of this same resistor is shunted for a microphone current of about 0.1 ampere. Either microphone or buzzer may be connected in for use at jack E. Modulation transformer T-1 appeared in the July, 1922 issue of RADIO NEWS. All filament wiring is kept very close to avoid inductive loops. Supports, cabinets and panels are of kiln dried

(*Continued on page* 194)



Appearance of a Completed Choke Coil of the Type Used in the Filter Circuit.

A Practical Switching Arrangement

By EUGENE R. WEBER, A.M.A.S.M.E.

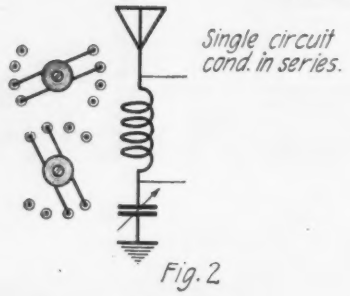


Fig. 2

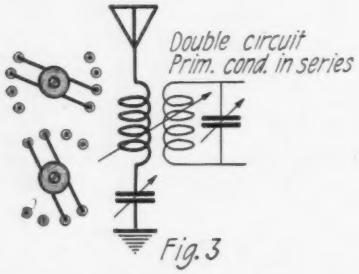


Fig. 3

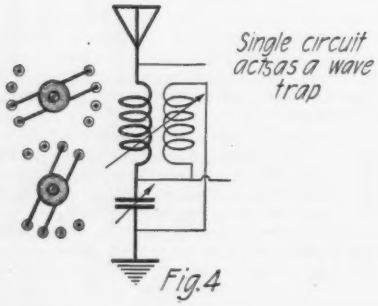


Fig. 4

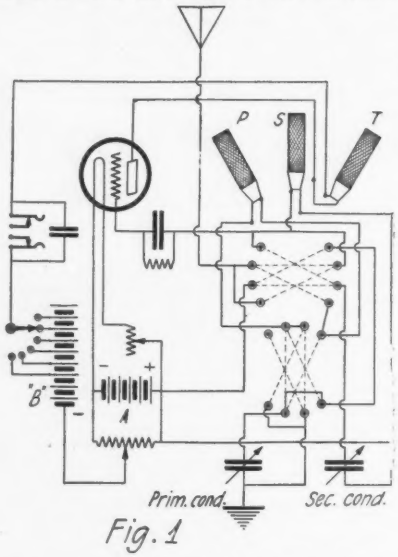


Fig. 1

By Using the Switches of the Series-Parallel Type, Any Number of Combinations Can Be Had, as Designated by the Switch Positions in the Accompanying Drawings.

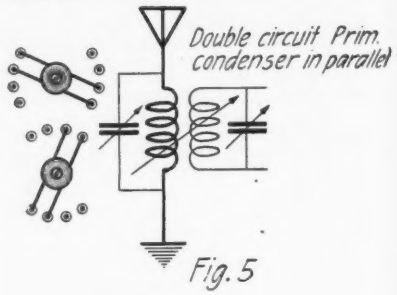


Fig. 5

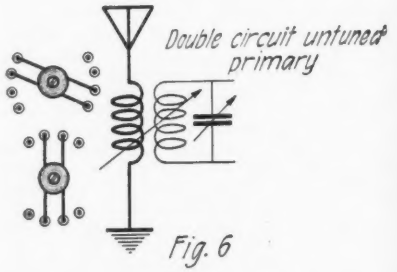


Fig. 6

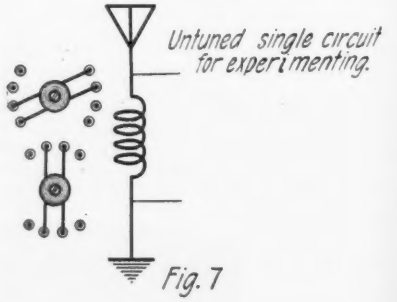


Fig. 7

HAVING tried both single and double circuits and proved their respective merits to my own satisfaction, I have come to the conclusion that both circuits are the best.

The single circuit is the easier to tune, provides a ready way of picking up desired stations, (as one soon becomes familiar with the position of the primary condenser dial for a given station) and signals can be heard readily that would not be heard on a double circuit. But it is not very selective.

A double circuit set is very much more selective, tuning out codes and other interference that it is impossible to tune out with a single circuit. It is impossible in most cases to pick up a desired station with a double circuit set for the reason that it is much more selective and, for that reason, is more difficult to tune.

Therefore, a single circuit set is the better for picking up a desired station, and a double circuit set for selectivity.

For the above mentioned reasons, I have worked out the switching arrangement shown herewith in Fig. 1, whereby I can switch from a single circuit (after I have tuned in the station I desire to hear and note what they are broadcasting) to a double circuit and turn the secondary condenser dial until I hear the same voice or song, etc., and I am reasonably sure that when the station announces, it will be the station I desire to hear, also that a large percentage of interference will be eliminated. The positions of these switches and the circuits obtained are shown in Figs. 2 to 10.

The writer used a regenerative hook-up with honeycomb coils, but the same arrangement would apply to a non-regenerative set or any other type of coils.

I am sure that anyone trying this switching system will be more than repaid for his time and trouble. All the equipment necessary are two series parallel switches and a few feet of wire.

Elimination of Reradiation Interference

By D. R. CLEMONS*

WHEN receiving broadcast programs there are usually many undesirable noises due to other regenerative receiving sets in the vicinity, or transmitting stations on slightly different wave-lengths. Good selective receivers overcome these to a certain extent. For ordinary coupled receivers using plate and grid variometers, and for receivers equipped with a tickler coil for regeneration, a very simple and efficient little device may be easily built which greatly or completely reduces whistling due to other receivers and interference due to transmitters tuned close to the desired wave-length, yet does not change the desired station's signal strength or characteristics at all.

The method employed is to insert a decade resistance box into the antenna circuit, as shown in Fig. 1. In operation with various receivers and antennae, whistling and parasitic noises might be heard even though the receiver were ordinarily critically adjusted. Then about 80 ohms is added in the box; immediately the signal fades, but is brought back by readjusting the plate variometer or filament current slightly. The signal then stands out clearly as before, but without the usual disturbing noises. By again increasing resistance and slightly retuning, the desired station can be made very loud.

Resistances required on different antennae are about 60 to 250 ohms, so any decade box may be employed if it is non-inductively wound and capable of adjustment from zero to 350 ohms in 10-ohm steps. If these are to be built for this purpose, the box may be quite small, but should be permanently mounted for use in the station. Since the unit is not extremely critical, resistors may be accurate to, say, 5 per cent,

*Radio Instructor, Dodge's Radio Inst.

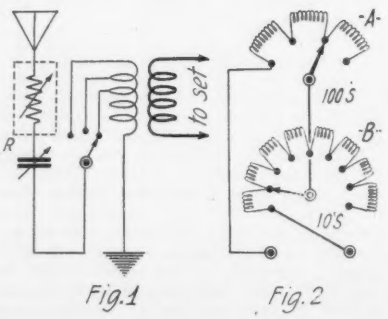


Fig. 1 Fig. 2

The Decade Resistance of Fig. 2 is Represented by "R" in Fig. 1. This Should Be Variable, in Steps of 10 Ohms.

so after determining the resistance per foot of the wire to be used, lengths may be roughly approximated and wound upon small wooden or cardboard bobbins.

The instrument is built with two adjustments: one of 10-ohm steps, the second having three steps of 100 ohms each. Switch levers, contact points, binding posts and resistances are mounted upon a small ¼" bakelite panel 4" by 6". The wooden box is of ⅜" cypress, built to house the parts suitably, as shown in Fig. 3. One switch is provided with 10 contact points which increase values to 90 ohms; the upper switch has four contacts, building to 300 ohms. The resistances are, of course, most important and should be carefully made. Since the currents are very small, a fine resistance wire as, say, 30 or 38 gauge, may be used. If an ordinary continuous winding were employed, considerable inductance would result in the larger resistors which would, of course, detune the aerial circuit. So the winding is bifilar to make it nearly non-inductive. The wire for a resistance coil is first cut to length and then doubled. By starting the bight first, the two lengths wind in closely, coming to the terminals as a parallel pair. The scheme of winding in either Fig. 4 or Fig. 5 may be used. In Fig. 4, 12 small lengths are cut from a ⅜" diameter dowel pin (flag stick, etc.), each cylinder being 1¼" long, and is drilled through with ⅛" hole as at C, Fig. 4. The length of wire is doubled and the bight firmly bound to the bobbin with several turns of silk thread, D, Fig. 4, then wound in as evenly as possible until about 1" remains from terminals, where it is again wrapped with thread and given a coat of shellac. These 10- and 100-ohm units are mounted as shown in Figs. 3 and 4, where each wooden bobbin is slipped over a match-stem forced into holes arranged in a semi-circle close to the contact points; a drop of glue holds the bobbin securely. Connections are made by soldering both terminals to contacts as in Fig. 2. In winding the larger 100-ohm units, two layers of winding may be required. Another method is to wind the wire about a slab of bristol-board or fibre cut ⅜" by 1¼", as shown in Fig. 5 at E. Such units may be mounted by gluing the strips into slots cut into a narrow strip of wood, G in Fig. 5. The entire resistance may be wound upon one long strip bent into a semi-circle, taps being made at 10-ohm intervals for the smaller 90-ohm group.

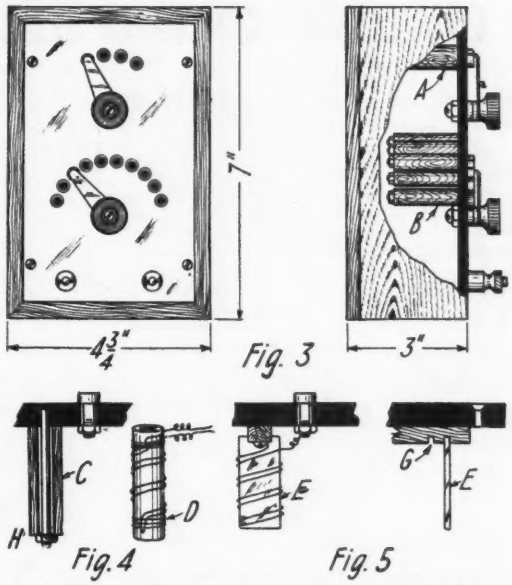
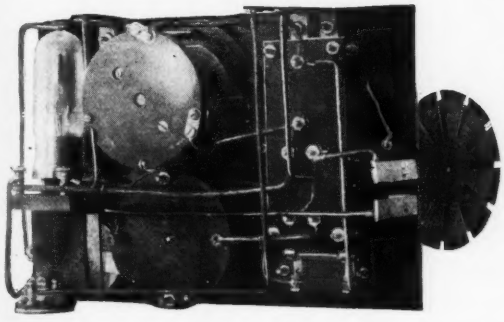


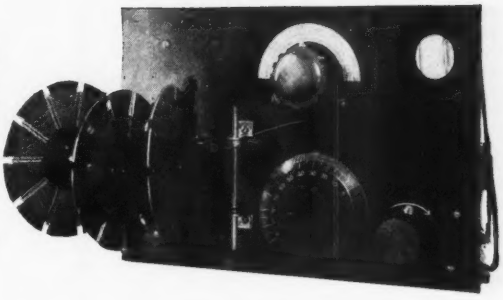
Fig. 3 Gives the Constructional Details for the Decade-Resistance Box. Figs. 4 and 5 Show the Manner in Which the Resistance Units Are Wound and Attached to the Panel. No. 36 Manganin Wire is Suitable.

A Well Constructed Portable Set

By C. B. SIDES



Two Views of the Portable Regenerative Set Built by Mr. Sides. As Seen, Spiderweb Coils Are Employed for Primary, Secondary and Tickler. Tuning is Accomplished by Two Variable Condensers.



THIS entire set, with the exception of the "A" and "B" batteries, is contained in a box 10" by 6½" by 2¾". The covering of this cabinet is of modeled leather and when closed would grace any drawing room table.

On the right hand side of the panel is the tube socket, tube rheostat and phone jack, all of which are mounted as one unit upon a strip of brass, being insulated from each other by mica insulators. All exterior battery connections are made from cord tip jacks mounted on the back of the panel. Two of these jacks are also used for plugging in the antenna and ground connections. Spider-web coils are used for tuning and connected up as a three-circuit regenerative hook-up, as shown in Fig. 1. These are of the plug-in type and when not in use, may be taken out and will fit nicely in the top of the box.

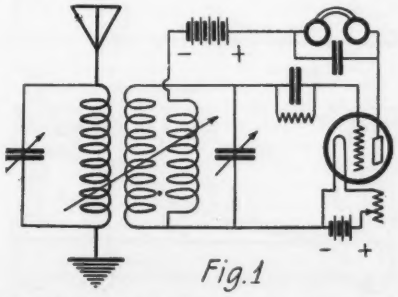
A Top View of Mr. Sides' Portable Set. Note the Arrangement for Adjusting the Spiderweb Coils.

Tuning is made more flexible by the employment of two .001 mfd. variable condensers, one being in parallel with the antenna circuit and the other in the secondary grid circuit, as seen in the diagram. A novel cam arrangement is used for adjusting the primary tickler coils, this method allowing the use of knobs some distance from the coils, thereby eliminating the annoyance of body capacity. This set has given exceptional results.

From my home in Buffalo, New York, I have picked up broadcasting stations in Dallas, Atlanta, Jefferson City, Louisville, Kansas City, Pittsburgh, Toronto, and some others.

With the type of coils used, regeneration is very easily controlled, being progressive, thanks to the loose coupling between the coils. In this set either a WD-11 or UV-199 tube may be used, the A and B batteries, phones and antenna wire being carried in another box of about the same size as the receiver. If it is desired to receive longer wavelengths larger coils may be plugged in and the receiver is then suitable for the reception of foreign press or high power stations.

For the vacationist who does not want to carry a heavy load but wishes to have a radio set with him, this type is truly ideal.



The Circuit of the Portable Receiver Described in This Article. The Positive Pole of the "A" Battery Should Be on the Left Side, Instead of On the Right As Shown, When Such Tubes as the UV-199 or C-299 Are Used, Since They Function Best As Detectors With the Grid Slightly Positive.

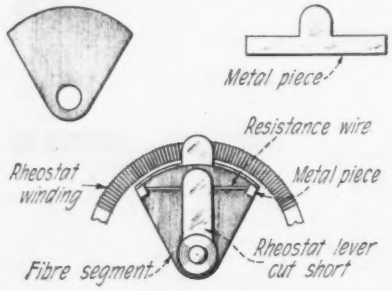
Awards of the $50 Radio Wrinkle Contest

First Prize

MAKING A VERNIER RHEOSTAT

By THOMAS W. BENSON

After a radio set is constructed, it is often found that the filament control is not sufficiently close for efficient operation. When such is the case and it is undesirable to replace the rheostats with vernier rheostats, an attachment can be made as shown in the



A Vernier Rheostat That is Easily Made. The Long Lever Moves Only When the Short Lever is at One or the Other Extreme End.

accompanying illustration that will convert the strip-wound rheostats into vernier control.

It is simply a segment of fibre cut to the shape shown, with a hole large enough to fit around the collar carrying the rheostat lever. A piece of spring brass or German silver is cut as shown and the ears bent up around the fibre with a short length of resistance wire that may be cut from the rheostat winding, clipped under the ears and soldered thereto. The extended piece is used to make contact with the rheostat winding, as shown in the view of the assembled vernier.

This attachment is put under the rheostat lever which is bent to touch the single wire. The operation should be clear. When the knob is turned, the whole device will turn and give rough adjustment, but backing up on the knob will cause the arm to move over the single wire, giving fine adjustment.

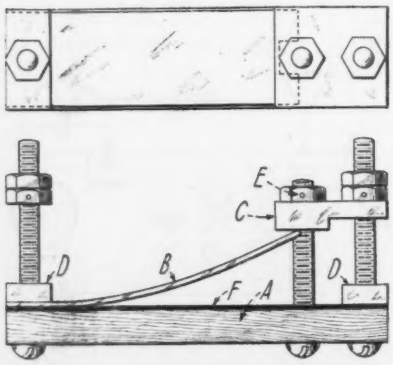
Second Prize

AN EXCELLENT VARIABLE GRID LEAK

By ALLEN H. FOX

The variable grid leak condenser herein described has been used for over a year, and for durability, ease and permanence of adjustment, can't be beat.

Referring to the drawing: "A" is a piece of hard rubber, bakelite or formica, on which is a strip of cloth "F," dipped in India ink and clamped firmly in place by pieces of brass strip "D." A strip of spring brass "B," made of copper or phospher-bronze, cuts out parts of "F" through the action of turning the machine screw which pulls "C" against "D." Either "A" or "C" must be threaded for this screw.



A Variable Grid Leak That is Free from Wear. The Spring Strip "B" Progressively Shorts the High Resistance "F" When Pressed Downward by the Adjusting Nut "E."

The two outside machine screws were placed 2⅛" on centers. This takes care of any of the flat rolled condensers on the market to-day. The correct grid condenser is fastened to the two outside screws with two nuts, together with the leads to the instruments.

"E" is an ordinary straight pin used to keep the nuts from turning. Two nuts turned up tight may be used instead.

This instrument is preferably mounted with the screw heads up or the adjusting screw at the top. This affords a dust protector over the leak proper and also facilitates adjustment which can be done with a well insulated screwdriver. In this way a continuous adjustment can be obtained without removing the hand, to eliminate body capacity.

PRIZE WINNERS

FIRST PRIZE, $25

Making a Vernier Rheostat

By THOMAS W. BENSON
2508 E. Mammouth St.,
Philadelphia, Pa.

SECOND PRIZE, $15.

An Excellent Variable Grid Leak

By ALLEN H. FOX,
615 Ontario St., S. E.,
Minneapolis, Minn.

THIRD PRIZE, $10.

A Fool-Proof Vernier Attachment

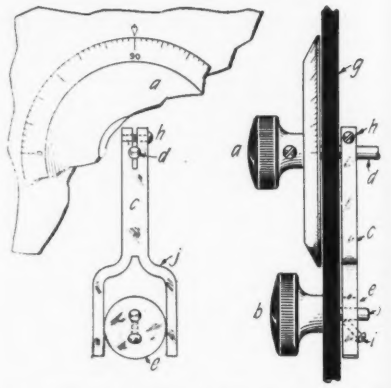
By BODO TA-BELL,
3824 Maybelle Ave.,
Oakland, Calif.

Third Prize

A FOOL-PROOF VERNIER ATTACHMENT

By BODO TA-BELL

The following is a description of an easily constructed Vernier attachment that is smooth in its operation and that has no back lash. The customary dial "A" is connected to the shaft "D" by a set screw, said shaft controlling a variometer, variocoupler, variable condenser or other instrument. Most of the instruments are placed about ⅜ of an inch, or more, from the panel, which gives ample room for this attachment. This Vernier is made of a piece of brass "C," about ¼"x⅜" and about 5" long. This bar is slotted 2" along its length and bent to shape, as at "J." At the other end a hole is drilled, slightly larger than the shaft. The set screw "H" at the slotted end is adjusted so that the bar slightly drags on the shaft. The knob "B" has a short shaft, to which is fastened an eccentric piece of fibre. "G" is the panel. Rough tuning is accomplished by rotating the dial, after which a fine adjustment is made with the knob "B." In case there is not room enough at the back of the panel, this arrangement can easily be mounted on the front so as to be between the panel and the dial.



This Type of Mechanical Vernier Works Very Well. Its Operation Relies on Friction and is Controlled by a Rotating Cam.

A COMPACT AERIAL

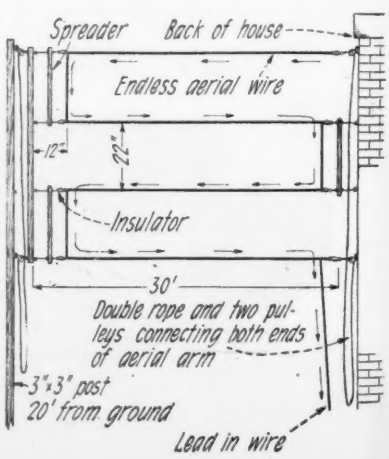
I have an aerial erected in my back yard and it's such a "howling" success, I would not change it for a little bit. Have used it for two months and have been roof gazing in that time on my travels along our elevated railroads and I have not seen any constructed along the same lines as mine.

I am sure none could be more successful and because of that fact and the originality of it (although some other fellow may have arrived at it the same as I), I am sending you a sketch of it. I have tried to make the sketch as clear as possible. The usual rule for an aerial is to have a swinging horizontal arm at each end. I have a vertical arm at each end strapped to the mast. Using a pulley and rope at both the top and the bottom of each vertical arm, I am able to draw the entire aerial as tight as a fiddle. The top of the aerial is on a level with the roof of a two story house, and I do not experience the effect of a pocket.

I tried a tap on each length of the aerial with no success and came back to the one tap on the lowest wire (like the sketch) and it proved the most successful.

I believe the success is mainly due to the manner of control I have of always being able to draw up a little on any corner of the aerial and having it always nice and tight, thereby always getting good results. Would be glad to have any of your subscribers call here and look it over.

Contributed by C. Oliver Corry.



The Novel Aerial Built by Mr. Corry, of 1925 Fontaine St., Philadelphia. Excellent Results Are Claimed.

Correspondence from Readers

THE ITCH FOR DISTANCE

Editor, RADIO NEWS:

After reading an article by Armstrong Perry entitled "The Itch for Distance," which appeared in RADIO NEWS for April, I feel that there is a logical defense which might be set forth for "Sarcoptes Scabiei" or itchmite of radio.

Those of us who continually seek new stations in preference to listening in all evening to local broadcasts are not afflicted by any such itch as Mr. Perry describes. Rather, we are impelled by the same urge which brought about the development of the boat, the automobile, the telephone, telegraph, the airplane and every other invention or device which has had as its object the elimination or reduction of the disadvantages which distance has had upon the inhabitants of the earth since the origin of man.

Mr. Perry's article brings to mind the old song which has been often sung in meetings of the Grange as well as at other gatherings of farmers entitled "Don't Leave the Farm, Boys." Judging from the number of Captains of Industry who lead the nation today, the old song either was not sung enough or did not make a very strong appeal.

It is my opinion that men are prompted to tune in to stations as far distant as practicable from them by an inherent curiosity to ascertain whether radio developments embodied in their set have actually cut down the effect of distance.

We know by instinct that when we are brought in contact with people who live at a distance from us, we will develop interests which we will share in common. Time and again this has made us more broad-minded. As a Nation, we are united because 48 states share a large number of interests in common. We become more united as a Nation as we develop a greater number of such interests.

The desire of the man in the East to listen in to concerts broadcast from the Middle West will eventually result in the development of a receiving apparatus that will enable us to receive any or almost any station in the country. When such a set is generally used, we will understand and appreciate the viewpoints of the cotton grower of the South, and the lumberman, miner or fruit grower of the West.

I recently listened in to a talk which the speaker stated was made to "You farmers of the Great Northwest." It was a talk on the value of the radio to farmers isolated from almost all the influences of civilization. *It made me think.* It is my recollection that the broadcasting station was WHA at Madison, Wis. I received an entirely different viewpoint. If I could hear such a talk from other sections of the country I would consider myself a better American citizen because I would be more familiar with the general problems of the country and was not surfeited with only such interests as might be classed as purely local. Had it not been my "misfortune" to be afflicted with the described itch, I should never have heard the talk mentioned above. In fact, I should have been unable to keep my set tuned in to this station all the time it was broadcasting.

The fact that so many try station after station without waiting to hear the programs broadcast may be accounted for to a certain extent by what they hear being broadcast. Frankly I will admit that whenever I hear "Lovin' Sam" broadcast, or its equivalent, I invariably tune out the guilty station and try for something which to me is more acceptable. I can get all of that I want right near home.

In short, I think that it is just as reasonable to expect radio fans to try for distance in receiving broadcasts as it is for men to try to travel faster or by more direct routes. The earth is our home and no matter if at times it does seem large, we will eventually master it. These poor itch-crazed fans are no different from the pioneers of old, except that they may do their exploring from the comforts of an easy chair in a well lighted and warm room.

Yours, until all the peoples of the world are made one by radio.

O. E. ROBERTS, JR.,
Washington, D. C.

CONFIRMATION

Editor, RADIO NEWS:

We are pleased indeed when we find someone who is fair and square enough to tell the truth as he sees it, although it may squeeze someone's toes. Your article, "The Radio Experimenter," in the May number of RADIO NEWS, is the "best ever." My firm has been building crystal sets since January 1, and, with no exception, each and every one of over 200 installed has a range of approximately 600 miles, without batteries or tubes. As you know, of course, the salesman (expert), the newspaper (expert), and the assistant engineers (very expert) invariably say the range of a crystal set is 25 miles. Tell 'em, Mr. Gernsback, for you certainly made a few hundred friends in this burg this time.

W. H. WHITNEY,
Cleveland, Ohio.

Interesting Articles Appearing in the August Issue of "Practical Electrics"

Loud Speakers and Movies.
Dry Weather Electrical Storms.
Studying Lightning. Dr. Albert Neuburger.
Experimental D.C. Transformer. By Amedeo Giolitto.
Cutting Metals with Electric Arc.
Novel Electrophorous. By Dr. Alfred Gradenwitz.
Silver Plated Leyden Jars.
Plante Storage Battery.
Magnetic Gravity Motor.
Wheatstone Slide Wire Bridge. By A. P. Peck.
New York's Electric Map. By T. O'Conor Sloane, Ph.D.
Windshield Cleaner.

A GOOD IDEA

Editor, RADIO NEWS:

If I knew code I should have a more kindly feeling toward the ham who intrudes on my concert programs and I think the great majority of the novices would feel the same softening influence.

It has just dawned on me that here is a great chance for the amateur to create a kindly feeling in his favor. That he needs a friend at court is only too manifest. Almost every listener in on radio would be glad to know enough code to enable him to get into the game as a listener, but almost every one finds it too hard after perusal of the code card to follow even the slowest code that he hears. Neither does he wish to spend money on a sending machine as he has no intention of being professional and reimbursing himself from wages.

Here is where the amateur fits in. Let him send some slow code, not the ordinary jargon of abbreviations, but well rounded sentences on matters of general interest. I really believe that if the amateurs here and there put in a few minutes at this now and then they would find that instead of being execrated they would be listened to eagerly. Let such a friendly amateur ask for cards. He will get them and more and more as his pupils take hold. Is not this worth trying? If it goes well, the society of amateurs could enlarge it to a system.

Here also is your chance, Mr. Gernsback. I am only a little insignificant crystal set listener and my letter is likely to pass unnoticed or be casually read, but if *you* boost it, it will go.

JUNIUS T. HANCHETT,
Antrim, N. H.

WE WILL

Editor, RADIO NEWS:

I was very much pleased to note that your judges awarded seventh prize to my answer to your "Who Will Save the Radio Amateur" contest.

Since writing the article I have continued to test for interference with local radiophone listeners, and in one case succeeded in securing very profuse apologies from one ardent radiophone fan who operates a Westinghouse R.C. and Magnavox about one mile from my station. He admitted after the test that he had been blaming me for "noises" that continued after my station signed off. At the present time (being a conscientious soul) he is busy retracting all the things he ever said about me to all his and my friends.

I am operating a 10-watt tube set, with a four-wire T-type aerial in the attic of my house (about 25' long) and a 20' lead, single wire, to the set. With 375 volts on the plate this set has been heard 90 miles on phone, and reported QSA in Milwaukee, Kalamazoo, Gloversville, N. Y., Philadelphia, Pa., and Washington, D. C., on C.W.

All my radio education has been secured from RADIO NEWS, which explains why I take up your time "strutting my stuff" in the paragraph above.

The most important thing in connection with the prize contest for me now is, of course, the $25. I have selected several of your advertisers who will get the greater part of it.

I hope you will continue to be prosperous so that you may have many more prize contests.

FRANK H. FANNING,
Radio 9KZ,
Ashland, Ky.

WHAT DO YOU THINK?

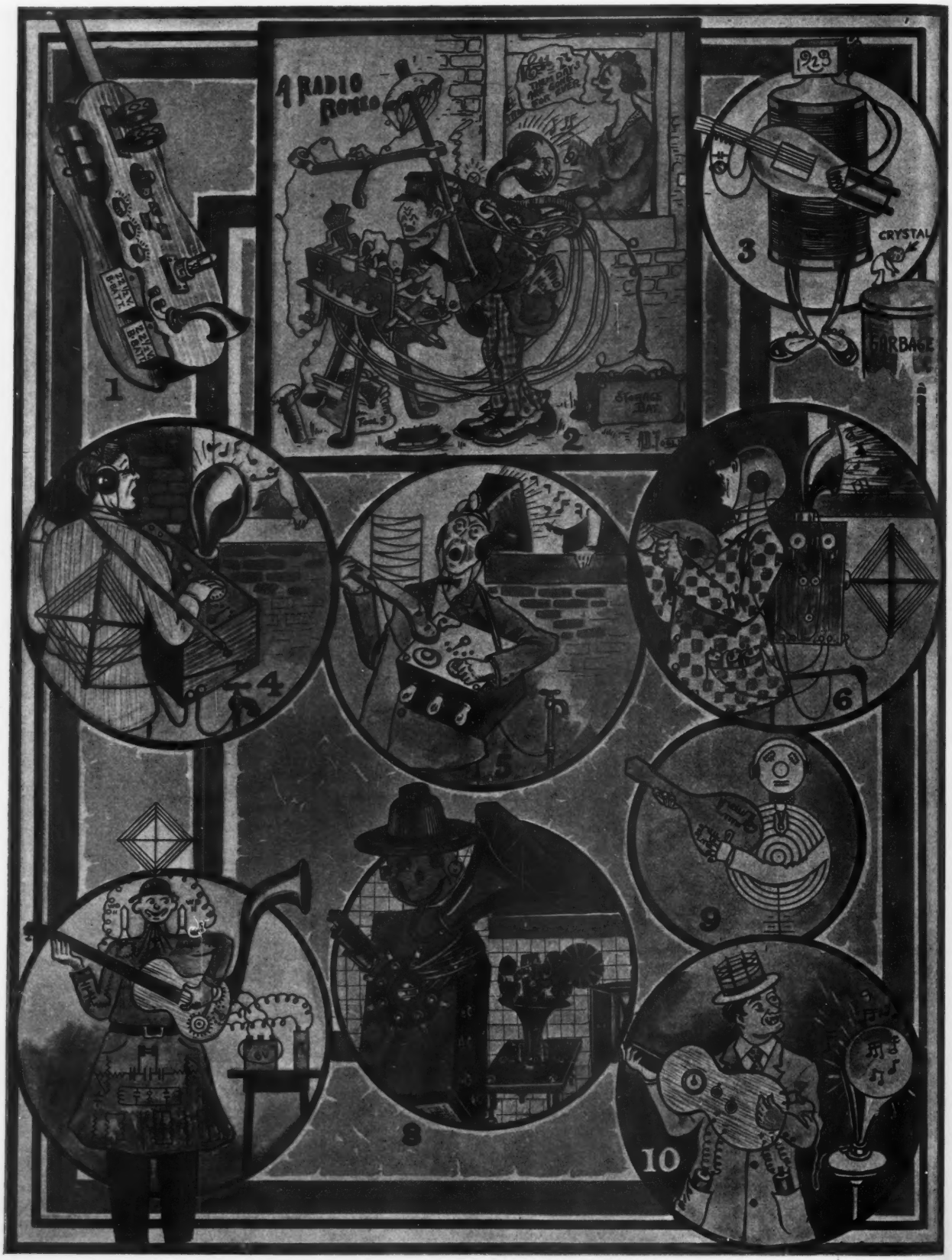
Editor, RADIO NEWS:

A question has been uppermost in my mind for some time, and I have as yet failed to find an answer. I am sure that some one has found it, and it seems logical to assume that RADIO NEWS is the medium through which the answer may appear.

If you or I were to ask any man, who declares himself an expert on Wireless Telegraphy or Radio, if it is possible for one living over 200 miles from the nearest broadcasting station to receive broadcast programs successfully, using a simple crystal receiver, what would he say? We know that he would say that since the working range of a simple crystal receiver is from 25 to 50 miles, greater distances are improbable. It has been said hundreds of times, and those very words have discouraged many a would-be radio enthusiast of limited means.

(*Continued on page* 194)

Prize Winning Sketches in the Cover Contest



Sketches Nos. 4, 5 and 6, First Prize, Won by Mr. L. B. Robbins. Sketch No. 2, Second Prize, Won by Mr. A. B. Fogle. Sketch No. 10, Third Prize, Won by Mr. G. E. Mitchell. Sketch No. 8, Fourth Prize, Won by Mrs. Cora M. Ward. Sketch No. 7, Fifth Prize, Won by Mr. J. A. Walter Ransom. Sketch No. 3, First Honorable Mention, Awarded to Mr. Lenard F. Howard. Sketch No. 9, Second Honorable Mention, Awarded to Mr. G. Bonhag. Sketch No. 1, Third Honorable Mention, Awarded to Mr. L. C. Craddock.

Awards of Our Cover Prize Contest

IN our April issue we announced our $100.00 cover prize contest.

As it will be remembered, on account of our big radio shower party, it became necessary to mutilate our cover design for which we apologized and to show that we really meant it, we offered $100.00 in prizes for the *best* suggestion of the hidden design of this cover.

Well, the contest was a howling success. It also showed us something we did not know before; namely that many of our readers, not only 100, but thousands, seem to be budding artists, who know how to wield the pencil as well as the brush.

A total of 2,856 designs and illustrations were submitted, the greater majority of the entries being accompanied by designs. But there was the usual fly in the ointment. Most of the contributors did not take the trouble to read our conditions and we reprint the following from the April issue:

"Cut out a piece of white paper and put it over the circle in our printed cover. Then draw a picture giving *your* version of the Radio Romeo."

The result was that the greater majority sent in designs that were substantially the same as our artist's original, which was used on our May cover. This, however, was not at all what we wanted. We wanted a *different* design, *not the one which was obvious and logical.* For that reason we said that we wanted *your* version of the Radio Romeo.

In awarding the prizes, we have been guided by originality and humor and we trust that everyone is satisfied. Those who in advance duplicated our own Radio Romeo may feel consoled by the fact that they had guessed our own version correctly. We are glad to say that there were a great many hundreds who, without ever having seen the design printed a month later on the May cover, came marvelously close to the original.

We thank our readers for the great interest they have shown in the contest.

Prize Winners

FIRST PRIZE, $50
L. B. Robbins, Harwich, Mass.

SECOND PRIZE, $20
A. B. Fogle, 705 Miller Ave., Shelbyville, Ind.

THIRD PRIZE, $15
G. E. Mitchell, 3330 Eastside Ave., Cincinnati, O.

FOURTH PRIZE, $10
Mrs. Cora M. Ward, R. F. D. 6, Schenectady, N. Y.

FIFTH PRIZE, $5
J. Walter Ransom, 41 Carlisle St., Hanover, Pa.

FIRST HONORABLE MENTION
Lenard F. Howard, 983 W. 6th St., Los Angeles, Calif.

SECOND HONORABLE MENTION
George Bonhag, 229 North 19th St., East Orange, N. J.

THIRD HONORABLE MENTION
L. C. Craddock, East 1028 Mission Ave., Spokane, Wash.

Results of the Radio Shower Party

AFTER considerable delay and labor on the part of the judges, we are at last ready with the results of the Radio Shower Party. Since thousands responded, we were unable to award all the prizes in time for the publication of the complete list of winners in the July issue of RADIO NEWS.

Due to the fact that not many listeners in the distant zones were able to pick up Broadcasting Station WJZ, the answers from these points were few. This left a number of unused prizes in the 4th, 5th, 6th, 7th, 8th, 10th, 11th and 12th zones. In order to make use of these, the list of prizes of the 2nd zone were rearranged and the left-over prizes of the other zones included. This was done because of the tremendous response from the 2nd zone. This revised list is published below, together with the names and addresses of the winners. The lists of prizes for the other zones are unchanged in their order, as published in our April issue.

There is no doubt that the Radio Shower Party met with great success. We are in hopes that all who participated will be satisfied. The judges did their best in making the awards and feel that each and every decision was justifiable.

Prize Winners

ZONE 1

Prize	
1st	L. Cleveland, 57 Richmond Ave., Worcester, Mass.
2nd	H. Reichard, Manchester Green, Manchester Green, Conn.
3rd	M. Coffin, Box 682, Groveland, Mass.
4th	E. J. Guillemette, 98 Monroe St., Norwood, Mass.
5th	Wesley C. Newcomb, Auburn, N. Y.
6th	A. E. Sinell, 207 Holden St., Worcester, Mass.
7th	J. D. Guilemette, 1LO, 70 Magill St., Pawtucket, R. I.
8th	W. S. Atwood, 1CUH, 80 Sea St., New Haven, Conn.
9th	E. R. Edgecomb, 14 Hempstead Ct., New London, Conn.
10th	Geo. Olson, 18 Frank St., Stamford, Conn.
11th	H. J. Baker, 584 Columbia Rd., Dorchester, Mass.
12th	E. S. Pack, Briggs Corner, Attleboro, Mass.
13th	E. J. Munroe, 120 Waterman Ave., East Providence, R. I.
14th	C. W. Radoslovich, 16 Perth Rd., Arlington 75, Mass.
15th	E. von Szupping, 276 Orchard St., Bridgeport, Conn.
16th	E. H. Clask, 29 Linden St., E. Hartford, Conn.
17th	I. O. Miner, Spring St., E. Greenwich, R. I.
18th	E. E. Davis, Sagamore, Mass.
19th	Mrs. C. C. Alvord, 441 Pleasant St., Worcester, Mass.
20th	D. E. Docekal, 550 Mechanic St., Fitchburg, Mass.
21st	J. M. Osborne, 49 Mountfort St., Suite 3, Boston, Mass.
22nd	P. A. Chadwick, 251 Cedar St., Bridgeport, Conn.
23rd	W. Balch, 46 Green St., Hudson, Mass.
24th	Bert Rinck, 54 Washington Ter., Bridegport, Conn.
25th	H. Schroeder, 23 Walker St., Salesville, R. I.
26th	J. C. Geer, 11½ Pratt Ave., Beverly, Mass.
27th	R. H. Given, care Island Falls Garage, Island Falls, Me.
28th	H. L. Andrews, 242 Waban Ave., Waban, Mass.
29th	G. U. Anderson, Waterbury, Conn.
30th	H. J. Mackin, 208 Hurd Ave., Bridgeport, Conn.
31st	S. D. Parsons, Box 86, N. Gorham, Me.
32nd	J. E. Bates, 86 Maple Ter., Mittineague, Mass.
33rd	D. Fine, 226 Smith St., R.F.D. No. 3, Attleboro, Mass.
34th	E. L. Scott, 647 Broadway, E. Providence, R. I.
35th	E. F. Weston, Holliston, Mass.
36th	G. E. Allen, Hazardville, Conn.
37th	Miss E. M. Rice, 143 Mass. Ave., Suite 6, Boston 17, Mass.
38th	A. Worth, 102 Main St., Nantucket, Mass.
39th	F. A. Rowe, Church St., Manchester, Mass.
40th	R. A. White, 182 Pearl St., Holyoke, Mass.
41st	L. Cowles, 100 Lodge Rd., Burlington, Vt.
42nd	W. G. Hazard, 35 Greenough Ave., Jamaica Plain, Mass.
43rd	P. C. Michel, R.D. No. 1, W. Suffield, Conn.
44th	R. B. Waterhouse, P.O. Box 92, Bourne, Barnstable Co., Mass.
45th	J. E. Frisbee, Portsmouth, N. H.
46th	A. Simard, 14 Rockdale Ave., Lowell, Mass.
47th	S. W. Trippe, 24 Holmes Ct., Portsmouth, N. H.
48th	R. C. Arnaud, Greenfield, Mass.
49th	W. T. Dungan, 68 New Britain Ave., Hartford, Conn.
50th	W. C. Crooks, Pascoag, R. I.
51st	E. Kauth, Lakewood, R. I.
52nd	Miss E. T. Wilson, 61 Morgan St., New Bedford, Mass.
53rd	A. R. Nichols, Cowesett, R. I.
54th	E. Z. Lane, Mechanic Falls, Me.
55th	G. W. Brown, 6 Peters St., S. Boston, Mass.
56th	V. A. Perkins, 53 State St., Brewer, Me.
57th	L. Van Derlip, 40 Orchard St., W. Hartford, Conn.
58th	J. G. Park, Main St., Groton, Mass.
59th	T. Gretchell, 6 Cedar St., Plainville, Conn.
60th	R. J. Enscoe, 180 Newhall St., New Haven, Conn.

ZONE 2

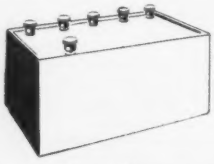
Prize	
1st	J. C. Dimmock, 1640 Macombs Rd., New York City
2nd	J. E. Porter, 101 You St., N. W., Washington, D. C.
3rd	R. Batcher, 745 So. 153th St., Jamaica, L. I., New York.
4th	R. D. Zucker, 507 Main St., Union Hill, N. J.
5th	C. G. Schultz, 30 North Mountain Ave., Montclair, N. J.
6th	J. F. Hughes, 3209 Park Ave. (Apt. 4M), New York City.
7th	Lawrence Abselon, Front Ave., Bronxville, N. Y.
8th	J. F. Swan, Box 285, Seneca Falls, N. Y.
9th	De Witt Stetten, Jr., 115th W. 87th St., New York City.
10th	J. E. Diamond, 40 Crary Ave., Mount Vernon, N. Y.
11th	R. Washburne, 100 Watching Ave., Plainfield, N. J.
12th	H. O. Wassmann, 14 W. Lincoln Pl., Freeport, N. Y.
13th	O. E. Roberts, Jr., 813 Ingraham St., N.W., Washington, D. C.
14th	H. M. Klotz, 600 W. 174th St., New York City.
15th	B. Manning, 60 N. Columbus Ave., Mount Vernon, N. Y.
16th	K. M. Swezey, 159 Milton St., Brooklyn, N. Y.
17th	J. Bister, 141 E. Post Rd., Mamaroneck, N. Y.
18th	V. R. Grobholz, 327 Woodward St., Jersey City, N. J.
19th	C. Peterson, 53 Elysian Ave., Nyack, N. Y.
20th	R. T. Shinn, P. O. Box 1225, Belmar, N. J.
21st	H. G. Elliott, Jr., Camp Alfred Vail, Oceanport, N. J.
22nd	L. H. Odell, General Delivery, Glen Echo, Md.
23rd	J. H. Smith, 1315 Harvard St., N.W., Washington, D. C.
24th	C. A. Jacoby, 57 Park Terrace, West Orange, N. J.
25th	Mrs. Mary E. Latey, 587 Riverside Dr., New York City.
26th	K. R. Van Tassel, 99 N. Genesee St., Geneva, N. Y.
27th	J. R. Flaherty, 1058 E. 98th St., Brooklyn, N. Y.
28th	E. Kiefer, Northport, L. I., N. Y.
29th	E. V. Hard, 1089 Delaware Ave., Buffalo, N. Y.
30th	J. Rosati, 943 E. 229th St., New York City.
31st	A. J. Banks, 2020 Lawrence St., N.E., Washington, D. C.
32nd	J. F. Dobson, Jr., 95 Driscoll Ave., Rockville Center, L. I., N. Y.
33rd	F. Graves, Andover, Andover, N. Y.
34th	J. E. Haway, Box 124, Katonah, N. Y.
35th	O. W. Homestead, 454 43rd St., Brooklyn, N. Y.
36th	E. C. Walter, 126 W. 129th St., New York City.
37th	H. B. Phelps, Buck Dorm., R.P.I., Troy, N. Y.
38th	E. L. Green, 34 Carroll Ave., Takoma Park, Washington, D. C.
39th	H. P. Truesdell, 29 Mountain Ave., Summit, N. J.
40th	J. A. Cahill, 823 Washington St., Hoboken, N. J.
41st	C. C. Odell, Fredonia, N. Y.
42nd	Nathan Pfeffer, 2132 Daly Ave., The Bronx, New York City.
43rd	S. T. Dickinson, Lieut. Pay Corps, U. S. N., P. O. Box 113, Times Plaza, Brooklyn, N. Y.
44th	Mrs. W. Koenig, 45 Smith St., Paterson, N. J.
45th	Jacob A. Buckwalter, care Independent, Collegeville, Pa.
46th	J. Henry, 14 Cross St., West Orange, N. J.
47th	H. W. Holcombe, 144 W. Fourth St., New York City.

(*Continued on page* 203)

Apparatus Awarded Certificates

NOVO "B" BATTERY

This "B" battery, which is manufactured by the Novo Manufacturing Co., of 424-438 W. 33rd Street, New York City, comprises 15 of the large type cells giving a total voltage of 22.5. The cells are enclosed in a heavy paper box and sealed in with sealing wax thus protecting the cells from moisture and prolonging the open circuit life of the battery. Standing idle for two months, the voltage remained constant at 22.5. When



placed on a 10-milliampere discharge rate, the voltage dropped to 22. At the end of 48 hours the voltage dropped to 18.5 and the current to 8 milliamperes, representing a total of 8.38 watt hours. On opening the circuit, the voltage increased to 19 and after standing idle for one day, the voltage rose to 20. There are 1½-volt taps from 16.5 volts to 22.5 volts. Each tap is provided with an insulated binding post cap so that there is little possibility of accidently short circuiting the battery.

Arrived in excellent packing.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 168.

MAGNAVOX LOUD TALKER

The Magnavox loud talker is of the electro dynamic type, comprising a movable coil attached to a metal diaphragm. The movable coil is placed in a powerful magnetic field, which is furnished by

an electromagnet energized by a 6-volt battery. Telephonic currents flowing through the movable coil cause it to vibrate up and down, perpendicular to the magnetic lines of force of the magnetic field. The movement of the coil is limited only by the elastic limit of the diaphragm, there being no pole tips to strike, as in the case of many other types of loud talkers. This accounts for the great amount of volume possible from this instrument. The impedance of the movable coil is very low, so that a step down transformer is used between the output of the amplifier and the movable coil. The electromagnet or field winding consumes one ampere at six volts. As high as 2,000 milliamperes of telephonic current may pass through the movable coil without injuring the instrument. When connected to our audibility meter and standing 6' from the horn, the sensitivity of the instrument was found to be greatest between frequencies of 360 and 3,800 cycles per second. The greatest sensitivity was found at 2,200 cycles, at which frequency the sound was just audible when the instrument was energized from a source of 22 microvolts. It required 4,000 microvolts to produce an audible sound at 160 cycles and 420 microvolts at 2,850 cycles. At 4,700 cycles only 126 microvolts were required to produce an audible sound, which indicates that this frequency must be near the resonance frequency of the diaphragm. The sensitivity was found to be practically constant within the above limits, which is necessary in order to avoid distortion. The sensitivity was about the same as that of other loud talkers of different makes. A metal horn is used, which is heavily coated with a "crystaline" finish which dampens out metallic sounds.

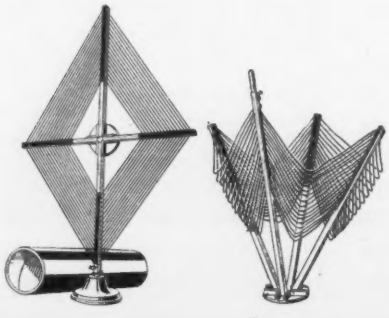
This instrument is manufactured by The Magnavox Company, 2701 East 14th Street, Oakland, Cal.

Arrived in excellent packing

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 167.

THE PORTENA LOOP AERIAL

The unique feature of this loop antenna, manufactured by J. Nazeley, Palisade, N. J., is the method in which it can be folded and packed in its tubular container, making it ideal for portable use. The antenna, when opened, snaps into place and can be set in the heavy metal support, which also acts as a cover for the tubular container when folded. There are 16 turns of wire, spaced about $\frac{5}{16}$". The outside of the loop measures 20" on each side.

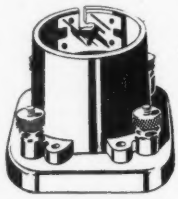


When shunted by a 23-plate variable condenser, the circuit responded to a wavelength range of from 190 meters to 650 meters, thus covering all the amateur and broadcast stations' wave-lengths. This loop is called the "Portena" by the manufacturer.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 184.

KELLOGG V.T. SOCKET

The vacuum tube socket shown in the illustration is of moulded red bakelite, with phospher bronze contact springs, insuring



tight contact with the prongs of the vacuum tube. The unique feature of this socket is the method in which the moulded material is strengthened at the slot in the side of the socket. Many sockets are weak at this point and break, while this socket is strengthened by means of a metal insert moulded into the material.

Arrived in excellent packing.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 182.

KELLOGG HEADSET

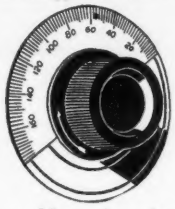
The Kellogg Switchboard & Supply Company, Adams and Aberdeen Streets, Chicago, Ill., has submitted for test the head-set which is shown in the illustration. This head-set we found to have a total resistance of 2,584

ohms, and was found to be very sensitive to frequencies ranging from 200 to 4,700 cycles per second, which include practically all of the audio frequencies used in modern broadcast receiving. In addition to being sensitive to weak signals, the head-set would also reproduce loud signals and music without distortion or rattling. The diaphragm is of small diameter and the pole tips are small, measuring ¼x$\frac{1}{16}$". The phones are the standard two-pole type. The head-band is so designed that the head-set can be worn with comfort.

Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 170.

SOMERVILLE KNOB AND DIAL

The metal dial shown in the illustration, which is manufactured by the Somerville Radio Laboratory, 176-178 Washington

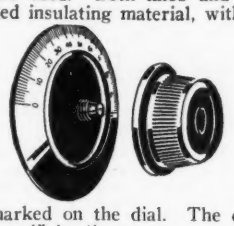


Street, Boston, Mass., is unique in that it is silver plated with a satin finish, so that station call letters or other notes can be marked directly on the dial. This will facilitate tuning in stations which were previously received and marked on the dial. Both 3" and 4" diameter dials were submitted. The knob is of moulded insulating material and fitted with a set screw for mounting on a shaft. The scale is distinctly stamped in black in the metal.

Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 171.

TAIT KNOB AND DIAL

This knob and dial, which are manufactured by the Tait Knob & Dial Co., 11 East 42nd Street, New York City, differ from the usual construction in their method of attaching to a shaft. There is a chuck arrangement, similar to that used on many drills, which fits over the shaft, after which the knob is screwed tight which clamps the knob and dial to the shaft, thus preventing slipping and insuring perfect alignment. No set screws are used. Both knob and dial are of moulded insulating material, with a scale

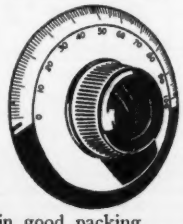


plainly marked on the dial. The dial submitted was 4" in diameter.

Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 173.

BELL KNOB AND DIAL

The Bell Mfg. Co., 11 Elkins Street, Boston, Mass., has submitted for test the 3½" dial shown in the illustration. This dial is of excellent moulded insulating material, and arranged to be attached to a shaft by means of a set screw, threaded in a metal bushing which is moulded in the knob. The construction is very accurate, insuring perfect alignment between the dial and the panel and shaft upon which it is mounted. The scale is clearly engraved on the dial.



Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 175.

RICO TRI-POLE HEAD-SET

The well-known tri-pole head-set, which is manufactured by the Radio Industries Corporation, 131 Duane Street, New York City, was found to be very sensitive to weak signals, and would also reproduce the loud signals and music with great volume and without distortion or rattling. The salient features of these phones are the simple magnetic system and the arrangement providing for adjusting the distance between the diaphragm and the pole tips. This is accomplished by means of a soft rubber washer placed under the diaphragm, which flattens out as the cap is tightened. There are three poles in each phone, one at the center which contains the winding, and two of opposite polarity from the center pole located diametrically opposite each other at the edge of the diaphragm. The cord is marked in order that the phones may be connected so that the current flowing through the magnet winding will assist the permanent magnetic field of the phones. They are made in 2,000, 3,000 and 4,000-ohm resistance. The 2,000-ohm phones were found to have a resistance of 2,026 ohms. The head-band is so constructed that the head-set can be worn comfortably.

Arrived in excellent packing, with instruction sheet enclosed.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 172.

WESKEN HEAD-SET

This head-set, submitted by Stevenson Brothers Sales & Engineering Co., Finance and Richlord Streets, Pittsburgh, Pa., is very small in size and was found to be extremely sensitive to weak signals. It would also reproduce loud signals and concerts, loud enough to fill a large room with sound, without distortion or rattling. The resistance was found to be 2,982 ohms. Tests were made at frequencies ranging from 200 to 4,700 cycles per second. The diaphragm is clamped directly on a metal back, thus preventing any changes in the distance between

the diaphragm and pole tips, due to unequal expansions from changes in temperature. The diaphragm is 1 13/16" in diameter and the pole tips ¼x$\frac{1}{16}$". The phones are of standard construction, employing two poles at the center of each phone. The shell and cap are of moulded material.

Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 174.

FROST HEAD-SET

H. H. Frost Company, 154 W. Lake Street, Chicago, Ill., submitted samples of both 2,000 and 3,000-ohm phones for test. These phones are shown in the illustration and are of moulded material and of standard construction, employing two poles at the center of each phone. The pole tips measure $\frac{1}{16}$x½". The sensitivity was measured at frequencies ranging from 200 to 4,700 cycles per second. The 2,000-ohm phones were slightly more sensitive than the 3,000-ohm phones. The phones would reproduce loud signals without distortion. The resistance of the 2,000-ohm phones was found to be

2,110 ohms, and the 3,000-ohm phones, 3,099.

Arrived in good packing.
THE 2,000-OHM PHONES ARE AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 176.
The 3,000-OHM PHONES ARE AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 177.

STROMBERG-CARLSON HEAD-SET

The 2,000-ohm head-set shown in the illustration was found to have a resistance of 2,106 ohms and was very sensitive to weak signals at frequencies ranging from 200 to 4,700 cycles per second. Loud signals were also reproduced without distortion. The shells are of moulded construction. The phones are of the conventional design, having two poles at the center. The pole tips are slotted in two places. The head-band is so designed that the phones may be worn with comfort, and can be clamped on

the ears tightly so as to exclude external noises. These phones are manufactured by the Stromberg-Carlson Telephone Mfg. Co., Rochester, N. Y.

Arrived in good packing.
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 181.

DICTOGRAPH HEAD-SET

The 3,000-ohm phones shown in the illustration, which are manufactured by the Dictograph Products Corporation, 220 West 42nd Street, New York City, were found to be extremely sensitive to weak signals and also reproduced the loud signals with-

out distortion or rattling. The phones are small in size, having diaphragms 1 1/13" in diameter. The pole tips measure ¼x$\frac{1}{16}$".

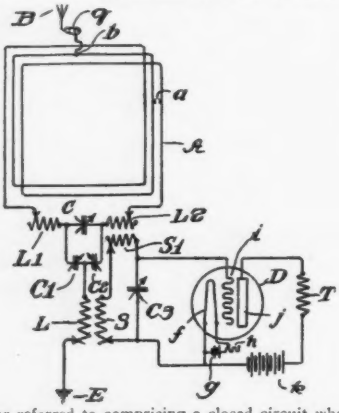
(*Continued on page 225*)

RADIO METHOD AND APPARATUS

(Patent 1,447,165, issued to Frederick A. Kolster, of Washington, D. C., Feb. 27, 1923.)

This invention relates to apparatus for transmitting or receiving electro-radiant energy or electro-magnetic waves for the transmission of intelligence, as for telegraphy or telephony, or for signaling in general, or for any other purpose.

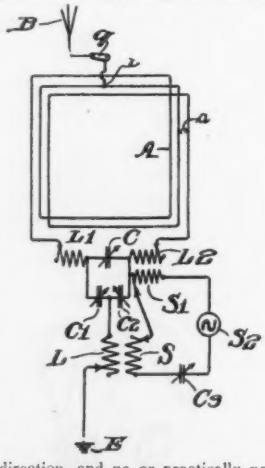
This invention resides in apparatus of the char-



acter referred to comprising a closed circuit whose distributed capacity and inductance are preferably very small or substantially nil, the closed circuit, and particularly the inductance or coil therein, operating as a capacity area connected through tuning apparatus, as variable inductance, with the earth or any counterpoise capacity.

Receiving apparatus embodying this invention is an absolute direction finder or a true radio compass whereby the location of a source of radiant energy may be determined. Such receiving apparatus serves also as an excellent interference preventer, that is, for permitting reception of signals from a desired station to the exclusion of signals from other stations differently located with respect to the receiving station, and to the exclusion of atmospheric or natural electrical effects.

Transmitting apparatus embodying this invention has the property of not only transmitting energy of greater intensity in some directions than others, but has also the property of causing transmission of energy of great intensity in a



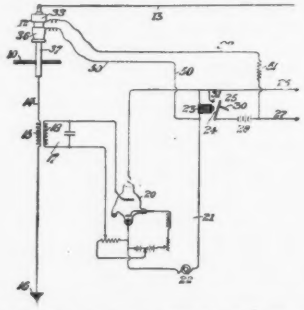
desired direction, and no or practically no energy in opposite direction.

There are shown two diagrammatic views of modified receiving and transmitting apparatus embodying this invention.

RECEIVING SYSTEMS FOR RADIANT ENERGY

(Patent 1,439,363, issued to John Hays Hammond, Jr., of Gloucester, Mass., Dec. 19, 1922.)

This invention relates to an insulator for supporting an antenna upon a marine vessel, such as a submarine or submersible torpedo. There are provided means, controlled by the insulator, for short-circuiting a signal controlled circuit, making it unresponsive to signals, when a wave or water

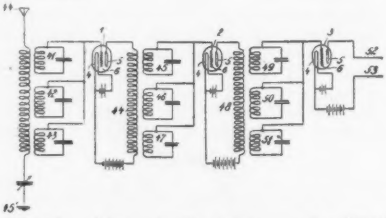


submerges the antenna support, and to restore normal operating conditions when the antenna support is out of contact with the water or wave. This pertains as well to systems wherein signals are transmitted for the operation of the control mechanism, for purposes of steering a torpedo or submarine, where, in such cases, it has been found that a wave washing over the antenna would break the said signal into two component parts, thus giving the wrong signal for the control mechanism. The main purpose of this invention is to insure a signal being broken into two or more separate signals through the action of waves.

METHOD AND APPARATUS FOR SELECTIVITY TRANSFERRING ELECTRICAL OSCILLATORY ENERGY

(Patent 1,438,828, issued to Harry W. Houck, of New York, N. Y., Dec. 12, 1922.)

This invention relates to a method and apparatus for transferring efficiently electrical oscillatory energy from one electrical system or circuit to another system or circuit without attenuation in such a manner as to simultaneously transfer electrical oscillations of any or all frequencies lying within a predetermined broad band of frequencies.



To this end the principle of resonance is utilized and it is expanded in accordance with this invention to provide what will be termed a sharply tuned electrical system for a broad band of frequencies, in contra-distinction to the usual sharply tuned system for a given frequency, or an extremely narrow band of frequencies, or, to the well known so-called broadly tuned systems. The expansion of resonance in accordance with this invention is accomplished by the use of a plurality of serially arranged electrically associated tuned oscillatory circuits, each of which is resonant to a given frequency, but whose collective effective resonance range includes or equals a broad band of frequencies. By interposing, coupling or linking the serially associated tuned oscillatory circuits with the source of electrical oscillatory energy, all electrical oscillations of frequencies lying within the effective resonance range of the tuned circuits will be transferred to the system or circuits electrically associated with tuned circuits without attenuation.

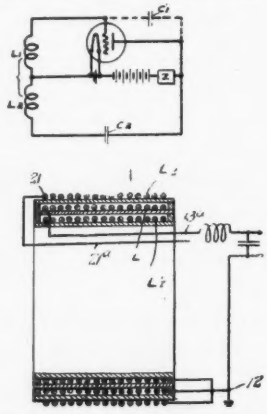
The invention may be utilized in connection with the generation, transmission and reception of electrical oscillatory energy, or, in the amplification of the received energy in wave signaling systems, it being particularly adaptable for this use.

METHOD AND ELECTRIC CIRCUIT ARRANGEMENT FOR NEUTRALIZING CAPACITY COUPLING

(Patent 1,450,080, issued to Louis A. Hazeltine, of Hoboken, N. J., March 27, 1923.)

This invention relates to the neutralizing of capacity coupling between two electric circuits, which capacity coupling results in the transmitting of undesirable disturbances from one circuit to the other.

It has long been known from practical experience that the presence of capacity coupling between the primary and secondary circuits of a radio receiver results in the transmitting of undesired signal oscillations, particularly those of short



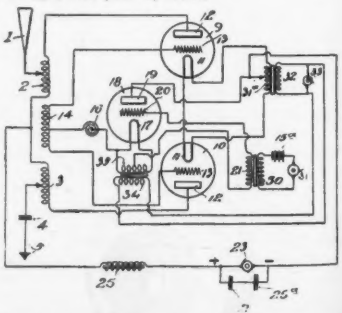
wave-length, from the primary to the secondary circuit. This reduces the selectivity of the receiver and frequently prevents the reception of the desired signal, which is drowned out by a more powerful signal of a different wave-length.

This invention is directed to the elimination of the undesirable effects of capacity coupling between two circuits such as are described in the foregoing examples. This is accomplished briefly as follows: An auxiliary circuit is provided which is electromagnetically coupled to one of the two original circuits which we will call the first circuit, and capacitively coupled to the other, or second circuit. If a disturbing voltage then exists in the second circuit, it will cause currents to flow both in the first circuit and in the auxiliary circuit, due to the capacity couplings. The electro-magnetic coupling between the auxiliary circuit and the first circuit is then arranged so that the magnetic effects of these two circuits will neutralize one another and so will result in no voltage across the first circuit. Conversely, if a disturbing voltage exists in the first circuit, it will result in no voltage across the second circuit, by the well known reciprocal properties of electric circuits.

The arrangement of the auxiliary circuit will depend on the forms of the original circuits. In some cases it is necessary to add coils or capacities to the original circuits to provide the required couplings, while in other cases the couplings may be obtained from coils present for other purposes or from inherent capacities.

RADIO COMMUNICATION

(Patent 1,440,834, issued to Charles V. Logwood, Chicago, Ill., Jan. 2, 1923.)

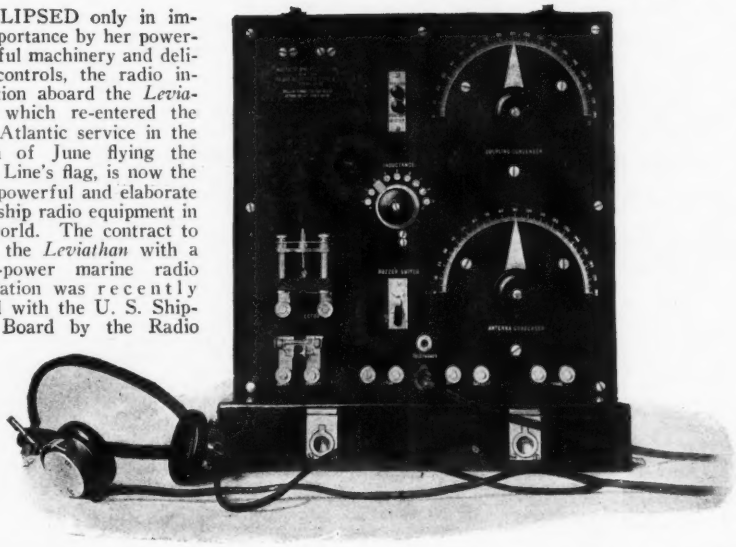


This invention relates to radio communication, and is particularly directed to systems that are employed for the transmission of signals through the medium of high frequency currents. The objects of the invention are to provide a signalling system which is simple and efficient and economical in manufacture, as well as the systems of the character set forth, wherein the electrical power of

(Continued on page 190)

Leviathan To Have Most Modern Radio Installation

ECLIPSED only in importance by her powerful machinery and delicate controls, the radio installation aboard the *Leviathan*, which re-entered the trans-Atlantic service in the month of June flying the U. S. Line's flag, is now the most powerful and elaborate steamship radio equipment in the world. The contract to equip the *Leviathan* with a super-power marine radio installation was recently signed with the U. S. Shipping Board by the Radio Corporation of America. This gives to America the distinction of radio supremacy upon the seas.



The Type of Receiving Set Installed in the Life-Boats of the Leviathan. These Were Especially Built by the Independent Co., for This Purpose.

Once a transporter of American doughboys and now a palatial hotel, the *Leviathan's* radio equipment will enable her passengers to exchange messages with two continents regardless of her position on the high seas. With equipment six times as powerful as that carried by the average ocean greyhound, uninterrupted communication with points 3,000 miles distant is assured. Upon leaving her berth in New York Harbor, the *Leviathan's* radio officers will be able to link the huge vessel with various marine centers in Europe and to communicate with America when leaving European ports.

In addition to telegraph service, a radio telephone installation which will provide voice contact with other vessels and shore stations is also to be installed. While it is not expected that a commercial telephone service will be inaugurated immediately upon the *Leviathan* going into commission, it is quite probable that shore stations will, in the no distant future, be erected to handle wireless telephone traffic from ships in mid-ocean to points inland over the conventional land line system. When such arrangements have been made passengers and officers on vessels at sea may establish contact with those on shore at their homes or offices and speak with them with the same facility and ease that accompanies an ordinary telephone conversation.

Aside from its commercial importance, the protection of life at sea is the chief function of marine radio service. That this vital function be performed with a degree of reliability exceeded by no other vessel afloat, the installation on the *Leviathan* will permit simultaneous communication by telephone and telegraph. A special emergency set will also be installed. Thus, should one or two sets become imperative due to a mishap, the third or emergency set may be relied upon to summon assistance. Furthermore, two of the life boats are fitted with emergency radio apparatus.

The principal transmitter consists of a high-power vacuum tube outfit which will deliver to the main antenna about six times as much power as the apparatus now used on the average steamship. A rapid transfer switch will enable the operator to shift the wave-length of this transmitter in an instant. The second is a duplex telephone outfit which will permit simultaneous telephone and continuous wave telegraph communication. The third or emergency sending equipment is a standard spark set which will normally operate on 600 meters. Several super-sensitive vacuum tube receivers will be used for reception.

Lifeboat Radio On the Leviathan

By CLAUDE CATHCART LEVIN

THE *Leviathan* in addition to being equipped with the most modern radio apparatus on any merchant ship in the world will have two of her lifeboats fitted with transmitting and receiving apparatus equal to that fitted on many vessels as the main unit. The apparatus on both boats is identical so that a description of the installation on one will suffice for both. The boat is not an ordinary lifeboat but is 50' long with an inclosed top and sides with two masts spaced 25' apart.

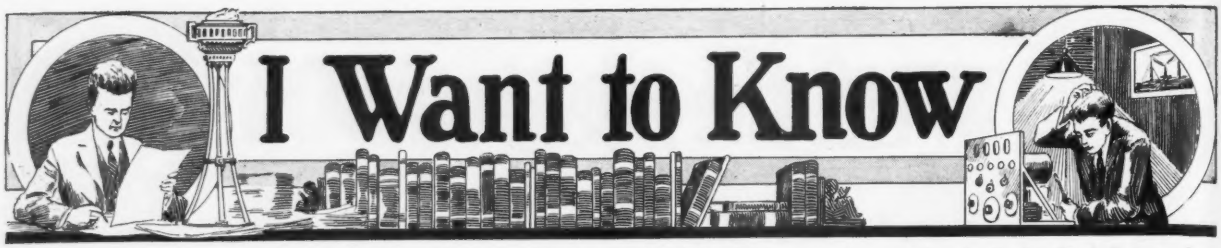
The lifeboat which is motor driven is divided into several water-tight compartments, in the mid ship one of which is located the radio apparatus. This boat and its sister is designed to tow the rest of the Leviathan's lifeboats, in case of disaster. Undoubtedly, the captain will have charge of one of these, should it be necessary to abandon ship. The compartment in which the apparatus is situated contains in addition, only an operating table which has been specially built and a chair for the operator. The Morse key is mounted on the table in the regular manner.

The transmitting apparatus consists of a ½ K.W. panel quenched gap transmitter made by the Independent Wireless Telegraph Co. It is three feet high by eighteen inches wide, both ways, and is of the C. & W. impact type being mounted on the operating table. The motor which is specially wound for 32 volts is located underneath the table. A separate compartment houses the bank of six 32-volt Edison cells which will keep the set in operation for four hours. Leads come through the steel bulkhead to the motor. The batteries are charged by means of Keroel generating unit which runs independently of the main propulsion motor of the boat. The receiver has been especially built by the Independent Co. for this installation.

The antenna is unique in that it stretches from the bow to the top of the forward mast to the after mast and down to the stern. Its four wires begin at the bow at a single point and diverge to the mast head where they run parallel for the 34' distance between the masts and then converge to a single point at the stern. The apparatus radiates two amperes on 600 meters and four amperes on 300 meters. At a test recently held at the ship yard in Newport News, the messages sent out were heard 170 miles away. The entire installation was inspected by representatives of the United States Shipping

(*Continued on page* 188)

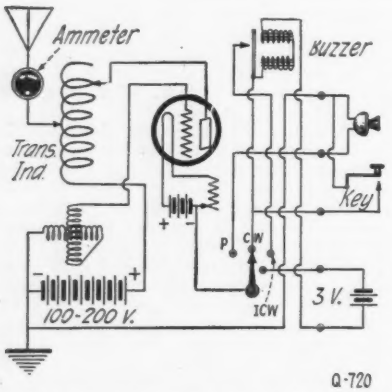
The ½-K.W. Quenched Gap Transmitter. It is Operated from a Bank of Edison Cells, Which Are Capable of Giving Continuous Service for Four Hours.



THIS Department is conducted for the benefit of our Radio Experimenter. We shall be glad to answer here questions for the benefit of all, but we can publish only such matter as is of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets. This Department does not answer questions by mail free of charge.
4. Our Editors will be glad to answer any letter, at the rate of 25c for each question. If, however, questions entail considerable research work, intricate calculations, patent research, etc., a special charge will be made. Before we answer such questions, correspondents will be informed as to the price charge.

You will do the Editor a personal favor if you will make your letter as brief as possible.



Here Is a Good Circuit For a Low-Power Phone, I.C.W. and C.W. Transmitter. This Is Similar to the Paragon 5-Watt Transmitter.

INDUCTION

(718) Mr. Wm. J. Moulton, Acushnet, Mass., writes:

Q. 1. I cannot understand how the current gets from the stator to the rotor of a variocoupler when there is no electrical connection. Please explain.

A. 1. This is what is known as induction. Any wire carrying current has a magnetic field, known as lines of force, surrounding it. If a wire or any conductor is drawn rapidly through these lines of force, a current is induced in the wire. As an alternating current is flowing in the primary of the variocoupler, the lines of force are expanding and collapsing in unison with the alternations of the current. When this happens it is equivalent to moving the secondary through stationary lines of force. When the magnetic field expands and collapses, it is cut by the stationary wire of the secondary, thus generating a current in the secondary winding. For a full explanation of induction we refer you to standard textbooks on radio.

TUBES FOR FLEWELLING CIRCUIT

(719) Mr. L. H. Montgomery, Jr., Nashville, Tenn., asks:

Q. 1. Please mention which tube is most successful in the Flewelling circuit.

A. 1. Any hard tube may be used in this circuit, but an amplifying tube would give best results. We would suggest the UV-201-A or the VT-2.

5-WATT TRANSMITTER

(720) Mr. H. L. Pearson, St. Louis, Mo., requests:

Q. 1. Kindly publish a hook-up similar to the Paragon 5-watt transmitter. This can be used as a C.W., I.C.W. or phone transmitter.

A. 1. This hook-up will be found in these columns.

TAPPED H. C. COILS

(721) Mr. John D. Flewelling, Jr., Union City, Mich., asks:

Q. 1. Can a honeycomb coil be tapped? If so, how many taps should there be on a coil of 25 turns?

A. 1. A honeycomb coil can be tapped by soldering leads at certain intervals, on the side of the coil. This can be done with advantage with a large coil, but for one of 25 turns it would not be necessary.

DATA ON WAVE TRAP

(722) Mr. H. O. Ten Eyck, Bethlehem, Pa., wants to know:

Q. 1. What size wire and tube, and how many turns, should be used with a condenser of .001 mfd. capacity, for the construction of a wave-trap?

A. 1. This would depend upon the wave-length for which the wave-trap is desired. We presume that a trap for the broadcast wave-length is desired. This is constructed by winding 45 turns of No. 24 S.C.C. wire on a 3" tube. Shunted by a variable condenser of .001 mfd. it will respond to wave-lengths from 220 to 600 meters.

R. F. WITH STANDARD REGENERATIVE RECEIVER

(723) Mr. F. H. Manning, Portsmouth, Ohio, asks:

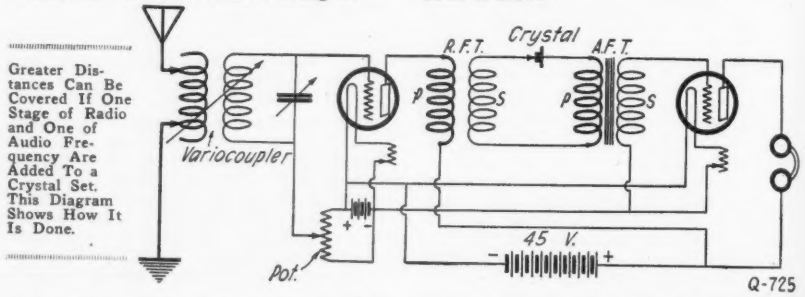
Q. 1. Please show the hook-up of Q. 616, in the March issue, with one stage of radio frequency added.

A. 1. It is not advisable to add only one stage of R. F. to a receiver using a variometer for regeneration, as the results obtained will be no better, as regeneration is sacrificed in this circuit. At least two stages would be needed before any improvement is noticed.

Q. 2. Will a multi-range or an all-wave coupler work well on this set?

A. 2. These instruments are designed to be used in a single-circuit receiver and would not function efficiently on the higher waves in a three-circuit receiver. The secondary inductance would be sufficient to tune to only about 500 meters, when shunted by a variable condenser of .0005 mfd. capacity.

Q. 3. Could I use more than 22½ volts on my detector tube (UV-200) without hurting it?



Greater Distances Can Be Covered If One Stage of Radio and One of Audio Frequency Are Added To a Crystal Set. This Diagram Shows How It Is Done.

A. 3. This depends entirely upon the characteristics of the tube. As a rule, this detector works best with from 18 to 22½ volts on the plate, but this must be determined by experiment.

COMBINATION TRANSMITTER AND RECEIVER

(724) Mr. H. M. Wolfe, Savannah, Ga., wants to know:

Q. 1. On the diagram shown in answer to Q. 659 of the May issue, describing a combination transmitter and receiver, what size honeycomb coil should be used for a 200 or 240-meter set?

A. 1. A coil of 25 turns should be satisfactory in this set, for this wave-length. All condenser capacities would remain the same.

Q. 2. Give data on length of antenna and number of wire for this set.

A. 2. A flat top, inverted "L" antenna, having a length of 60', can be used. Four wires are used, spaced at least 2' apart. The lead-in should not exceed 50'.

R. F. WITH CRYSTAL

(725) Mr. A. Valverde, Havana, Cuba, writes:

Q. 1. Please publish a hook-up showing how one stage of radio frequency can be added to my crystal set.

A. 1. This circuit appears on these pages.

Q. 2. May I add one step of radio frequency amplification to this set? Please publish this hook-up.

A. 2. This has also been shown on this diagram.

Q. 3. What results as to distance and volume of sound may I get from each one of them?

A. 3. With R. F. alone the range will be greatly increased although the volume will not be much greater than the crystal set. With the A. F. the volume will be about four times as great, but the distance will remain about the same as with the crystal set alone.

PHONES

(726) Mr. C. L. King, Edwards, Ill., requests:

Q. 1. What is the difference between 5-10-1000 ohm phones?

A. 1. The ohmage of a phone is determined by the number of turns on the pole pieces. A five-ohm phone would have comparatively few turns as compared with a phone of 1000 or 1500 ohms.

Q. 2. Which is best for a crystal or tube set?

A. 2. A pair of phones with an ohmage of 1000 for each phone is usually used for both crystal and tube sets.

Q. 3. What are the different kinds of transformers, and what are their uses?

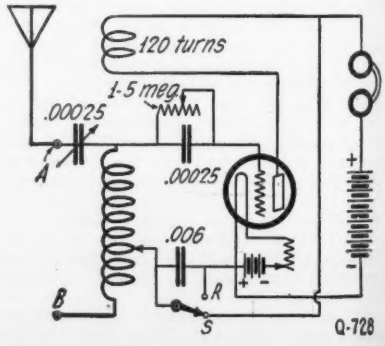
A. 3. There are many kinds of transformers, but we presume that you refer to transformers used in receiving sets. There are radio and audio frequency amplifying transformers. The radio frequency transformer is used to amplify the signals at radio frequency before they reach the detector. The audio frequency transformer amplifies the signals at audio frequency after they are rectified by the detector.

THE NEW WAVE-LENGTHS

(727) Mr. F. O. Stevens, Brooklyn, New York, wants to know:

Q. 1. Since the new broadcast wave-lengths have come into effect, I miss half of the stations because my set will not tune high enough. How can I raise my wave-length?

A. 1. Most of the sets in use today are unable to reach the higher wave-lengths, due to insufficient inductance or capacity in the secondary circuit. The secondary of the variocoupler should have at least 50 turns of wire to cover the new wave-lengths. The secondary may be rewound to this number, or a small fixed condenser of



The Improved and Simplified Flewelling Circuit Is Shown Here. Excellent Results Should Be Obtained From This Circuit.

about .0003 mfd. capacity may be connected in parallel with the secondary variable condenser. This condenser should have a switching arrangement, so that it could be cut out of the circuit for the lower waves. If a variometer is used to tune the secondary circuit, the fixed condenser should be connected from the filament side of the secondary to the grid side of the variometer. The primary of the coupler, as a rule, has sufficient inductance, but, if necessary, a honeycomb coil of about 35 turns may be connected in the antenna circuit. A honeycomb coil receiver can, of course, tune to any wave-length by simply changing the coils.

LATEST FLEWELLING CIRCUIT

(728) Mr. Wayne R. Hackett, Los Angeles, Cal., desires:

Q. 1. Kindly publish a hook-up of the Flewelling circuit:

A. 1. This circuit appears on these pages. A switch is used to change from "super" to plain regenerative. When used as a "super" either the antenna or ground may be connected to the antenna binding post. When used as a plain regenerative, the ground is connected, as shown by the dotted lines.

Q. 2. Can a switch be used in a radio frequency amplifier, to switch out the various stages?

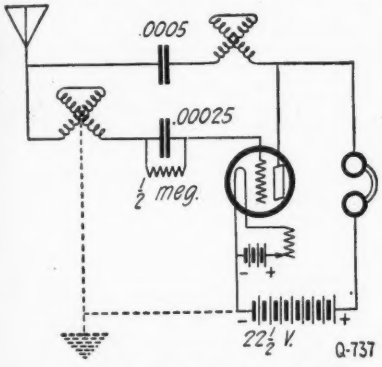
A. 2. For an arrangement of this kind a switch should be used for each stage. This has been shown in answer to Q. 471, in the October, 1922, issue of RADIO NEWS, which may be obtained from our circulation department.

QUERIES ON REFLEX

(729) Mr. S. M. Hurst, Prague, Okla., wants to know:

Q. 1. Referring to the reflex circuit shown in Q. 611, I would like to know if honeycomb coils would be better than a variocoupler using a variometer for regeneration.

A. 1. If regeneration is desired, honeycomb coils are recommended, as it is not possible to use as variometer for regeneration when radio frequency is used. We would not advise regeneration in this circuit, however, as it would only make the set a great deal more difficult to operate efficiently.



Very Good Results Are Claimed For This Circuit. If a Ground Is Used With the Aerial It Is Connected As Shown By the Dotted Lines.

Q. 2. What ratio should the transformers have?

A. 2. This depends upon the type of transformer and varies with each make, a ratio of two or three to one, is generally used in air core transformers.

TUNING TROUBLE

(730) Mr. Eugene H. Isaacs, New York City, writes:

Q. 1. I have a two-variometer and variocoupler receiving set and my aerial is about 250' long, including the lead-in. I get no tuning whatever on the taps or variable condenser in series with antenna. What is wrong?

A. 1. Your antenna is altogether too long for good results on the broadcast wave-lengths. The natural period of this antenna is about 340 meters, and we would suggest that you shorten it to 150' or less. You should also check your ground connection.

RADIOLA GRAND

(731) Mr. Harry Wilson, New Rochelle, N. Y., requests:

Q. 1. Please publish the circuit of the Radiola Grand, showing all values.

A. 1. This hook-up will be found in these columns. The push-pull method of amplification is used and special transformers are necessary. A tapped resistance is shunted across the primary of the second transformer to control the volume of sound.

MULTIPLE LOUD-SPEAKERS

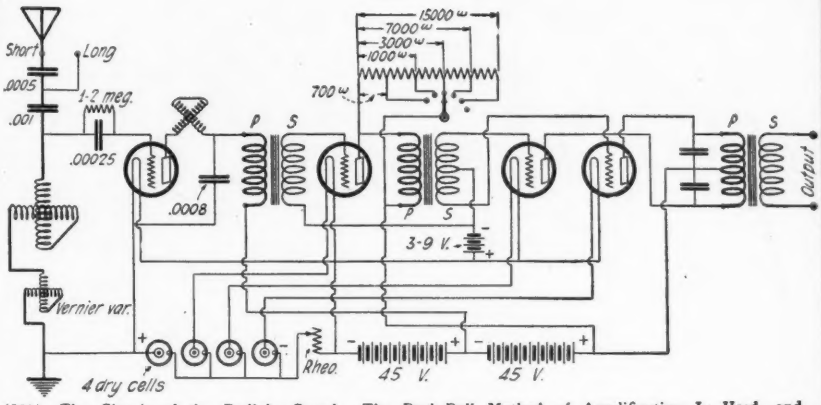
(732) Mr. O. Ingmar Oleson, Ambrose, N. D., writes:

Q. 1. Why cannot several loud speakers be operated from the same set, thereby increasing the sound?

A. 1. We do not believe that any noticeable increase in volume would be had with an arrangement of this kind. As this would constitute a divided circuit, the energy received by each loud speaker would be only a portion of the total, and the sound produced would be reduced in each loud speaker correspondingly.

Q. 2. Should the grid return be connected to the positive or negative of the "A" battery for the detector and amplifier?

A. 2. For the detector the grid return should be connected to the positive, and for the amplifiers to the negative side of the "A" battery.



(731) The Circuit of the Radiola Grand. The Push-Pull Method of Amplification Is Used, and Special Transformers Are Necessary.

QUESTIONS ON TUBES

(733) Mr. A. R. Marshall, Stony Creek, Va., asks:

Q. 1. Is the UV-199 superior to the WD-11, UV-200 or the UV-201-A as a detector?

A. 1. The UV-199, although not designed as a detector, gives very good results when used in this capacity. We believe that it will prove just as efficient as any of the aforementioned tubes when used in a detector circuit.

Q. 2. In a three-tube set, using UV-201-A tubes, how many dry batteries are used and how are they arranged?

A. 2. Four dry cells should be connected in series for the filament of the UV-201-A. It would be better, however, to use four more cells connected in parallel with the other four, to give longer life to the batteries.

A. F. WITH REINARTZ CIRCUIT

(734) Mr. Leslie E. Stone, Richmond, Va., requests:

Q. 1. Please show a hook-up with one or two stages added to the Reinartz circuit.

A. 1. This hook-up appears on these pages.

ANTENNA INTERFERENCE

(735) Mr. M. E. Lecroix, Montreal, Canada, wants to know:

Q. 1. Does an aerial installed on a roof cause non-reception from a loop used directly under the antenna?

A. 1. An antenna should affect the loop in no way under these circumstances. If the loop is in a steel building, reception might be impaired and the directional effect would most likely be nullified.

WD-11 AS AN AMPLIFIER

(736) Mr. H. I. Troan, Shellbrook, Canada, writes:

Q. 1. Will the WD-11 give the same volume on a loud-speaker as the standard six-volt tubes?

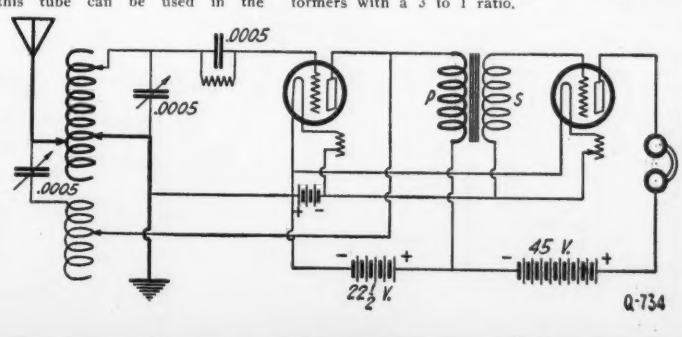
A. 1. Although fairly efficient as an amplifier, the WD-11 will not give as great a volume of sound as standard tubes, such as the UV-201-A or VT-2.

Q. 2. Can the WD-11 be used in the Flewelling circuit?

A. 2. Yes, this tube can be used in the Flewelling or any "super" circuit, but over 90 volts should not be used on the plate.

Q. 3. How many stages of R. F. amplification does it take to get a longer range than the Armstrong "super" circuit?

A. 3. A good regenerative circuit will, as a rule, receive longer distances than the "super," although the volume of sound will not be as great.



Audio Frequency Amplification May Be Added to the Reinartz Circuit By Following This Diagram.

A. & P. PHANTOM CIRCUIT

(737) Mr. Geo. H. Brauer, St. Louis, Mo., requests:

Q. 1. Please publish the hook-up of the Atlantic and Pacific Phantom Circuit.

A. 1. This circuit appears on these pages and it will be seen that it is a modification of the Reinartz circuit. If a ground is used to receive instead of the antenna, it is connected directly to the aerial binding post. A ground may be used with the aerial, by connecting it as shown by the dotted lines, and better results will sometimes be had with this arrangement. The ground connection is taken from the center of the variometer coil that goes to the antenna.

WAVE-LENGTH QUERY

(738) Mr. Lester D. Wise, Long Branch, N. J. asks:

Q. 1. Will a variable condenser (.001 mfd.) in antenna circuit shorten wave-length in hook-up, "Notes on WD-11 Tube" in the April RADIO NEWS? All I get is code.

A. 1. A condenser in the antenna circuit of any receiver will reduce the wave-length and give sharper tuning. You are evidently not tuning your set correctly.

Q. 2. Please show the hook-up of Prof. Hazeltine's Neutrodyne receiver.

A. 2. This circuit appeared in answer to Q. 902 in the July issue of RADIO NEWS.

QUESTIONS ON REFLEX

(739) Mr. S. T. Cochrane, Schuykill Haven, Pa., requests:

Q. 1. Please publish a hook-up of a three-tube reflex using a vario-coupler, 23-plate condenser with two stages of both radio and audio frequency amplication. A single circuit is desired with regeneration.

A. 1. This circuit was shown in answer to Q. 611 in the February issue of RADIO NEWS. A double circuit tuner is shown, but a single circuit may be used if desired.

Q. 2. Can UV-199 tubes be used in this hook-up?

A. 2. These tubes will give very good results in this circuit.

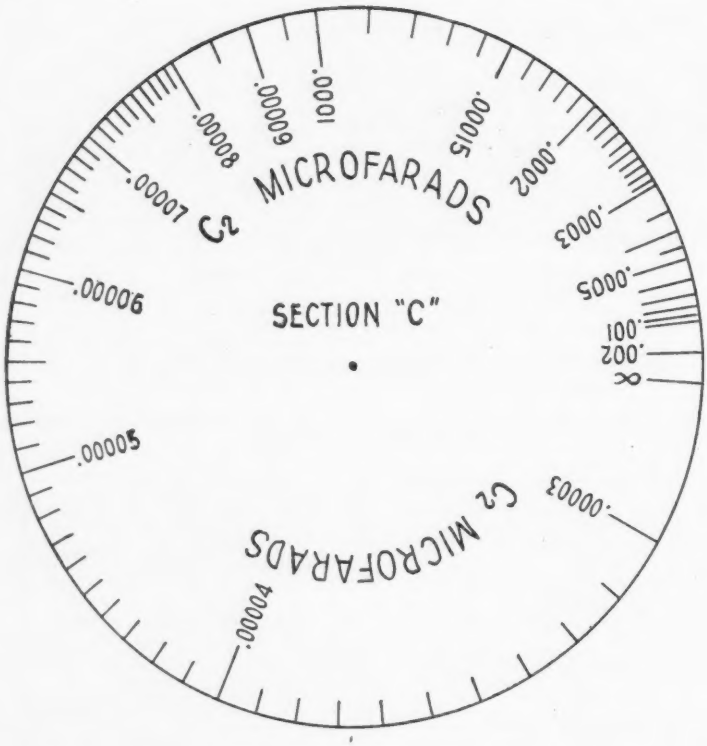
Q. 3. Will Acme transformers do? If so, what ratio should be used?

A. 3. Acme transformers should prove satisfactory in this circuit. The first stage of radio frequency should use R. F. transformer R.-2. The second stage should use an R.-3 transformer. Both stages of audio frequency should use transformers with a 3 to 1 ratio.

Practical Radio

By RALPH

Author of Prepared

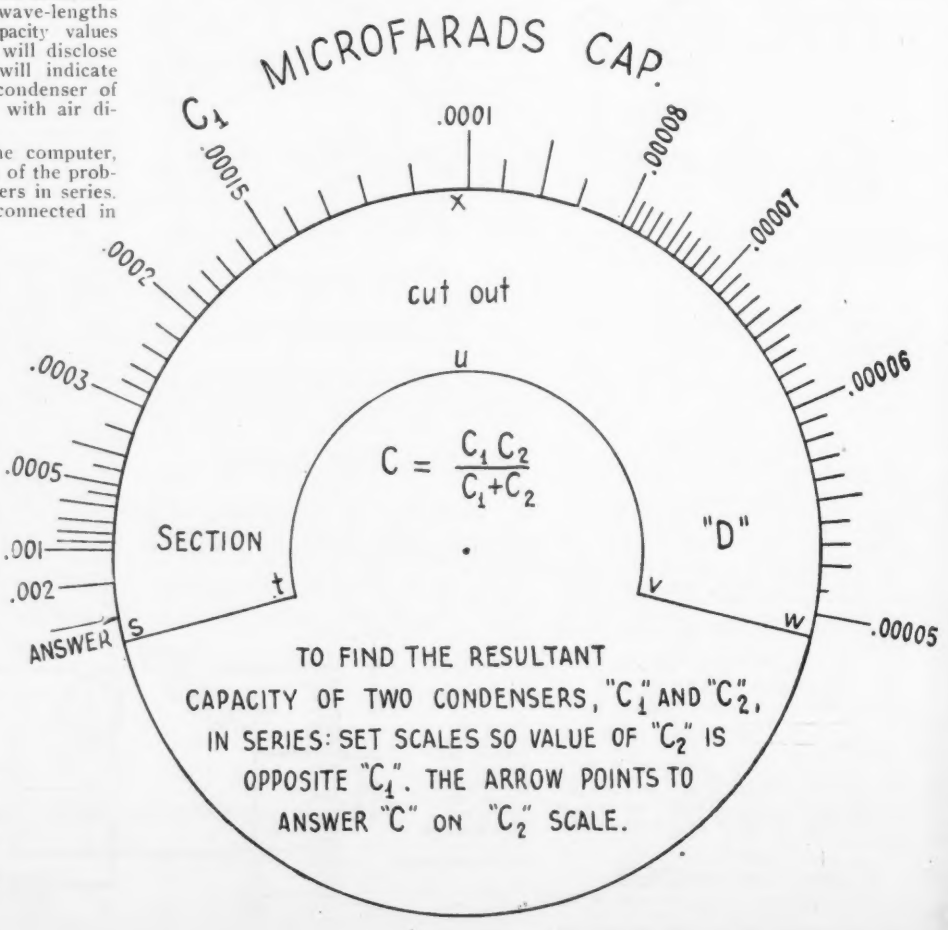


PLANS were published in the July issue for an easily constructed radio slide rule, designed to solve the special problems involved in the construction of layer-wound inductance coils, and in the determination of wave-lengths from the inductance and capacity values in the circuit. This article will disclose a similar instrument that will indicate the capacity of a variable condenser of the semi-circular plate type with air dielectric.

On the reverse side of the computer, other scales give the solution of the problem of two or more condensers in series. When two condensers are connected in series the resulting capacity is always less than that of either condenser alone, the exact value being ordinarily determined with the formula appearing at the center of the scale section C. This slide rule gives the answer to this formula directly.

In cases where three condensers are in series, determine the effective capacity of two of them in series and then determine the resultant capacity when the third condenser is connected in series with an imaginary condenser having a capacity equal to the answer obtained with the first two.

The scales have ranges greater than those required for ordinary radio frequency circuits. If, however, it is desired to use the chart for series condenser problems, for other ranges, multiply the three scales C_1, C_2 and C by .001, .01, 10 or 100, or any other factor desired and use as before. The only rule necessary to follow is to multiply each scale by the same factor.



CONSTRUCTIONAL DETAILS

Procure two smooth flat cards having their smaller dimensions somewhat larger than the largest of the accompanying scales. For convenience the four scales will be called Sections A, B, C and D. First cut out Sections B and D, in the form of a square, being careful not to trim away any of the numbers. Paste these scales on opposite sides of one of the cards, taking care that the centers of the circles coincide. The best way of doing this is to punch small holes with a pin in the center of each section B and D and another hole in the center of the card. When these three holes are in line, the centers are together. A small dot in the center of each section indicates where the hole should be punched. Dry the card after pasting, under pressure between flat surfaces to prevent warping.

Then paste sections A and C on opposite sides of the other card, getting the centers together in the same way, and dry flat. When dry, carefully trim off the edge around section A outside of the circle, leaving no margin. This leaves a round disc with scales on each side. It will be found that section C is a little smaller, but this is intentional.

Returning to the square card with sections B and D, cut out the circular slot on section D indicated by the letters "s-t-u-v-w-x," cutting clear through the card. This operation is best done with a sharp

Slide Rule

BATCHER

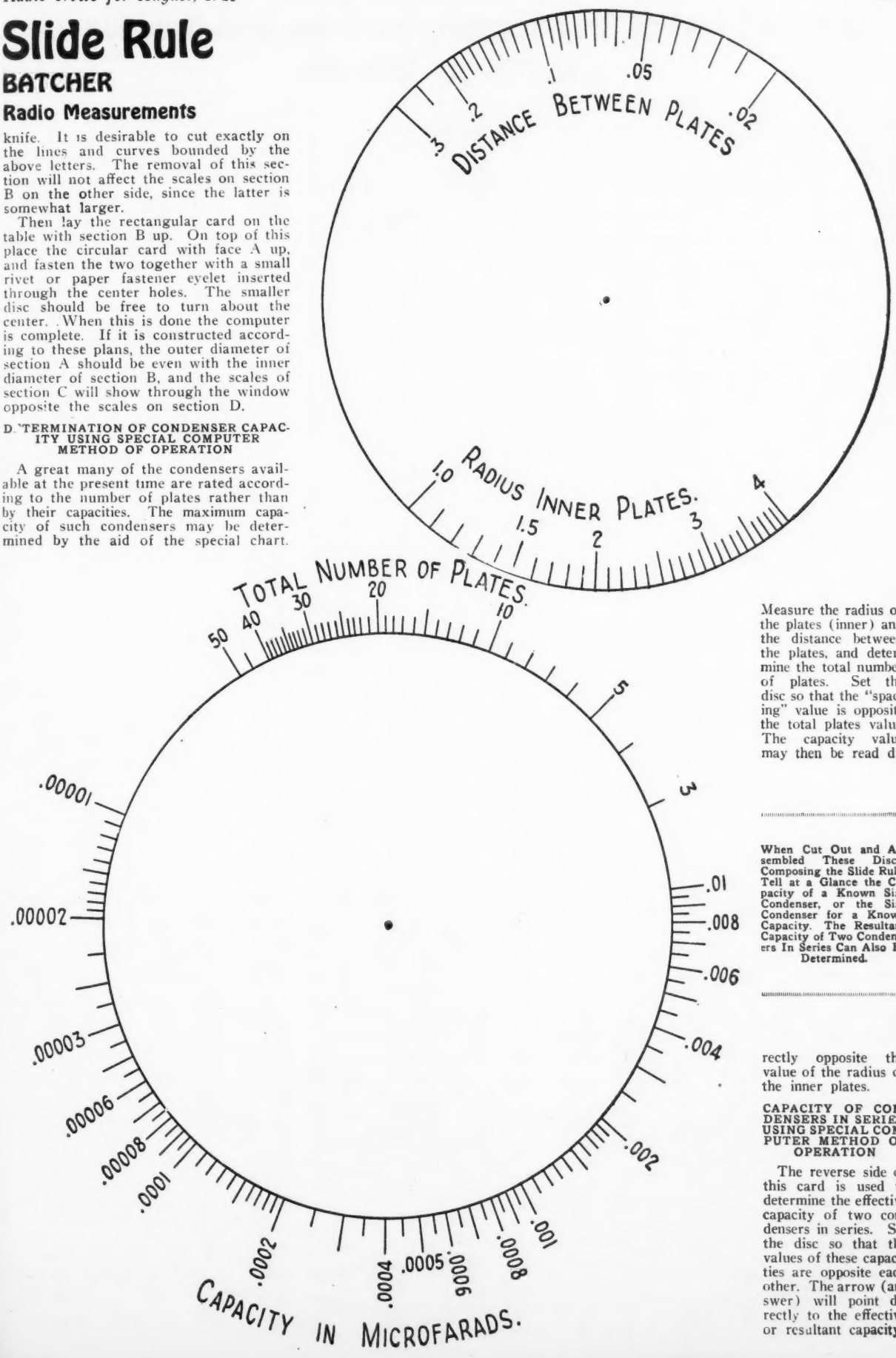
Radio Measurements

knife. It is desirable to cut exactly on the lines and curves bounded by the above letters. The removal of this section will not affect the scales on section B on the other side, since the latter is somewhat larger.

Then lay the rectangular card on the table with section B up. On top of this place the circular card with face A up, and fasten the two together with a small rivet or paper fastener eyelet inserted through the center holes. The smaller disc should be free to turn about the center. When this is done the computer is complete. If it is constructed according to these plans, the outer diameter of section A should be even with the inner diameter of section B, and the scales of section C will show through the window opposite the scales on section D.

DETERMINATION OF CONDENSER CAPACITY USING SPECIAL COMPUTER METHOD OF OPERATION

A great many of the condensers available at the present time are rated according to the number of plates rather than by their capacities. The maximum capacity of such condensers may be determined by the aid of the special chart.



When Cut Out and Assembled These Discs, Composing the Slide Rule, Tell at a Glance the Capacity of a Known Size Condenser, or the Size Condenser for a Known Capacity. The Resultant Capacity of Two Condensers In Series Can Also Be Determined.

Measure the radius of the plates (inner) and the distance between the plates, and determine the total number of plates. Set the disc so that the "spacing" value is opposite the total plates value. The capacity value may then be read directly opposite the value of the radius of the inner plates.

CAPACITY OF CONDENSERS IN SERIES, USING SPECIAL COMPUTER METHOD OF OPERATION

The reverse side of this card is used to determine the effective capacity of two condensers in series. Set the disc so that the values of these capacities are opposite each other. The arrow (answer) will point directly to the effective or resultant capacity.

Revised List of Broadcasting Stations with New Wave-Lengths to June 8th

Call	Station	Wave-Lengths
KFAV	Abbot Kinney Co., Venice, Cal.	258
WEAK	Abercrombie, Julius B., St. Joseph, Mo.	360
KFDA	Adler's Music Store, Baker, Ore.	360
WTAW	Agricultural & Mechanical College of Texas, College Station, Tex.	360
WMAV	Alabama Polytechnic Inst., Auburn, Ala.	250
WSY	Alabama Power Co., Birmingham, Ala.	360
WCAR	Alamo Radio Elect. Co., San Antonio, Texas	360
WGAW	Albright, Ernest C., Altoona, Pa.	261
KZM	Allen, Preston D., Oakland, Cal.	360
KGO	Altadena Radio Lab., Altadena, Cal.	360
WRAU	Amarillo Daily News, Amarillo, Tex.	360
WJAB	American Radio Co., Lincoln, Neb.	360
WG'	American Radio & Research Corp., Medford Hillside, Mass.	360
KFEZ	American Society of Mech. Engrs., St. Louis, Mo.	360
WEAF	American Telephone & Telegraph Co., New York, N. Y.	492
WIAU	American Trust & Savings Bank, Le Mars, Iowa	360
WPAA	Anderson & Webster Elect. Co., Wahoo, Neb.	360
WRAV	Antioch College, Yellow Springs, Ohio	360
WQAJ	Ann Arbor Times News, Ann Arbor, Mich.	360
KFI	Anthony, Earle C. Inc., Los Angeles, Cal.	469
WOAG	Apollo Theatre, Belvidere, Ill.	224
WQAK	Appel-Higley Elect. Co., Dubuque, Iowa	360
KQP	Apple City Radio Club, Hood River, Ore.	360
WFAT	Argus-Leader, Sioux Falls, S. D.	360
KFGL	Arlington Garage, Arlington, Ore.	234
WABG	Arnold Edwards Piano Co., Jacksonville, Fla.	248
WMAD	Atchison County Mail, Rockport, Mo.	360
WGM	Atlanta Constitution, Atlanta, Ga.	429
WSB	Atlanta Journal Co., Atlanta, Ga.	429
WDAJ	Atlanta & West Point R. R. Co., College Park, Ga.	360
WPAM	Auerbach & Guettel, Topeka, Kan.	360
KFEX	Augsburg Seminary, Minneapolis, Minn.	261
KFER	Auto Electric Service Co., Ft. Dodge, Iowa	231
KDZF	Automobile Club of So. Calif., Los Angeles, Calif.	278
WDAO	Automotive Electric Co., Dallas, Texas	360
WHAE	Automotive Electric Service Co., Sioux City, Iowa	360
KFBC	Azbill, W. K., San Diego, Calif.	360
WOAS	Bailey's Radio Shop, Middletown, Conn.	360
WEAR	Baltimore American & News Publishing Co., Md.	360
WOR	Bamberger, L. & Co., Newark, N. J.	405
WPAY	Bangor Radio Lab., Bangor, Me.	360
WABI	Bangor Ry. & El. Co., Bangor Me.	240
WBBD	Barbey Battery Service, Reading, Pa.	224
KFFZ	Barnes Amusement Co., Al. G., Dallas, Texas	226
WQAA	Beale, Horace A., Jr., Parkesburg, Pa.	360
WAAL	Beamish Elect. Co., Minneapolis, Minn.	360
WMAM	Beaumont Radio Equipment Co., Beaumont, Tex.	360
KDZR	Bellingham Publishing Co., Bellingham, Wash.	261
KFIF	Benson Tech. Student Body, Portland, Ore.	360
WEB	Benwood Company, Inc., The, St. Louis, Mo.	360
KRE	Berkeley Gazette, Berkeley, Cal.	360
KJS	Bible Institute of Los Angeles, Cal.	360
WRAN	Black Hawk Electrical Co., Waterloo, Iowa	229
KFHB	Boardwell, P. L., Hood River, Ore.	280
WKAY	Brennan College, Gainesville, Ga.	360
WMAN	Broad St. Baptist Church, Columbus, Ohio	360
WQAH	Brook-Anderson Elect. Eng. Co., Lexington, Ky.	254
KNN	Bullock's, Los Angeles, Cal.	360
KFDR	Bullock's Hardware & Sporting Goods, York, Neb.	360
KFEY	Bunker Hill & Sullivan Mining & Const. Co., Kellog, Idaho	360
WIAS	Burlington Hawk-Eye Home Elect. Co., Burlington, Iowa	360
WDZ	Bush, James L., Tuscola, Ill.	278
KFBB	Buttrey & Co., F. A. Havre, Mont.	360
WQAO	Calvary Baptist Church, New York, N. Y.	360
WJAQ	Capper Publications, Topeka, Kan.	360
KFDF	Casper Community Radio Corp., Casper, Wyo.	360
WQAW	Catholic University of America, Washington, D. C.	360
KFHF	Central Christian Church, Shreveport, La.	266
WDAD	Central Kansas Radio Supply, Linsborg, Kan.	360
WPE	Central Radio Co., Inc., Independence, Mo.	360
WLAS	Central Radio Supply Co., Hutchinson, Kan.	244
WNAQ	Charleston Radio Elect. Co., Charleston, S. C.	360
KFGP	Cheney Radio Co., Cheney, Kan.	229
WAAF	Chicago Daily Drovers Journal, Chicago, Ill.	286
WMAQ	Chicago Daily News, Chicago, Ill.	448
WJAZ	Chicago Radio Laboratory, Chicago, Ill.	448
KFGD	Chickasha Radio & Elect. Co., Chickasha, Okla.	248
KFBS	Chronicle News, Gas & Electric Supply Co., Trinidad, Colo.	360
WIAQ	Chronicle Publishing Co., Marion, Ind.	360
WDM	Church of the Covenant, Washington, D. C.	360
WIZ	Cino Radio Mfg. Co., The, Cincinnati, Ohio	360
KUS	City Dye Works & Laundry Co., Los Angeles, Cal.	360
WBU	City of Chicago, Chicago, Ill.	286
WRR	City of Dallas, Police & Fire Signal Dept., Dallas, Texas	360
KFAQ	City of San Jose, San Jose, Cal.	360
KFEB	City of Taft, Taft, Cal.	360
WON	Clark University, Worcester, Mass.	360
WSAC	Clemson Agricultural College, Clemson College, S. C.	360
KUY	Coast Radio Co., El Monte, Cal.	360
WHAC	Cole Bros. Elect. Co., Waterloo, Iowa	360
WQAL	Cole County Tel. & Tel. Co., Mattoon, Ill.	360
WOAK	Collins' Hardware Co., Frankfort, Ky.	360
KFCK	Colorado Springs Radio Co. Colorado Springs, Colo.	360
KFHA	Colorado State Normal School, Gunnison, Colo.	360
WMC	Commercial Publishing Co., Memphis, Tenn.	500
WAAH	Commonwealth Electric Co., Inc., St. Paul, Minn.	360
WCAZ	Compton, Robt. E., & Carthage College, Carthage, Ill.	360
WPAU	Concordia College, Moorhead, Minn.	360
WIL	Continental Electric Supply Co., Washington, D. C.	360
WIAH	Continental Radio Mfg. Co., Newton, Iowa	360
WEAI	Cornell University, Ithaca, N. Y.	286
WEY	Cosradio Company, The, Wichita, Kan.	360
WHAS	Courier Journal & Louisville Times, Louisville, Ky.	400
WHK	Cox, Warren R., Cleveland, Ohio	360
KFGQ	Crary Hardware Co., Boone, Iowa	226
WLW	Crosley Manufacturing Co., Cincinnati, Ohio	360
KFDO	Cutting, H. E., Bozeman, Mont.	248
WLAG	Cutting & Washington Radio Corp., Minneapolis, Minn.	417
WWB	Daily News Printing Co., The, Canton, Ohio	360
WCAG	Daily States Pub. Co., New Orleans, La.	360
WNAX	Dakota Radio Apparatus Co., Yankton, S. D.	244
WFAA	Dallas News & Dallas Journal, Dallas, Texas	476
WEAX	Daly, T. J. M., (Argenta), Little Rock, Ark.	360
WCAK	Daniel, Alfred P., Houston, Texas.	360
WEAU	Davidson Bros. Co., Sioux City, Iowa	360
WBAH	Dayton Co., The, Minneapolis, Minn.	360
WIAF	De Cortin, Gustave A., New Orleans, La.	360
WJX	De Forest Radio Tel. & Tel. Co., New York City	360
KFKH	Denver Park Amusement Co., Lakeside, Colo.	226
KZN	Desert News, The, Salt Lake City, Utah	360
WCX	Detroit Free Press, Detroit, Mich.	517
KOP	Detroit Police Dept., Detroit, Mich.	286
WCAV	Dice Electric Co., J. C., Little Rock, Ark.	360
KFHI	Dixon, Charles V., Wichita, Kan.	224
KFZ	Doerr Mitchell Elect. Co., Spokane, Wash.	283
WPAC	Donaldson Radio Co., Okmulgee, Okla.	360
KFAT	Donohue, Dr. S. T., Eugene, Ore.	275
WPAJ	Doolittle Radio Corp., New Haven, Conn.	268
WRK	Doron Brothers Electric Co., Hamilton, Ohio	360
KQV	Doubleday-Hill Electric Co., Pittsburgh, Pa.	360
WMU	Doubleday-Hill Electric Co., Washington, D. C.	261
WMAJ	Drovers Telegram Co., Kansas City, Mo.	275
WCAS	Dunwoody, Wm. Hood Industrial Inst., Minneapolis, Minn.	360
WCAU	Durham & Co., Philadelphia, Pa.	286
KFFE	Eastern Oregon Radio Co., Pendleton, Ore.	360
WRAK	Economy Light Co., Escanaba, Mich.	360
KMX	Electric Lighting Supply Co., Los Angeles, Cal.	360
KFCH	Electric Service Station, Billings, Mont.	360
KYQ	Electric Shop, Honolulu, T. H.	360
KFAN	Electric Shop, Moscow, Idaho	360
WLAV	Electric Shop, Inc., Pensacola, Fla.	360
WPI	Electric Supply Co., Clearfield, Pa.	360
WFAH	Electric Supply Co., Port Arthur, Texas	360
KDZI	Electric Supply Co., Wonatchee, Wash.	360
WQAM	Electrical Equipment Co., Miami, Fla.	360
KFGZ	Emmanuel Missionary College, Berrien Springs, Mich.	268
KSL	Emporium, The, San Francisco, Cal.	360
WCAH	Entrekin Electric Co., Columbus, Ohio	286
WTAS	Erbstein, Charles E., Elgin, Ill.	275
WBAV	Erner & Hopkins Co., The, Columbus, Ohio	360
WOAJ	Ervins Electrical Co., Parsons, Kan.	360
WWJ	Evening News Assn., Detroit News, Detroit, Mich.	517
KUO	Examiner Printing Co., The, San Francisco, Cal.	360
WEAA	Fallain & Lathrop, Flint, Mich.	360
KFHJ	Fallon Co., Santa Barbara, Cal.	360
WDAY	Fargo Radio Service Co., Fargo, N. D.	244
WRP	Federal Institute of Radio Telegraphy, Camden, N. J.	360
WGR	Federal Tel. & Tel. Co., Buffalo, N. Y.	360
WCE	Findley Electric Co., Inc., Minneapolis, Minn.	360
WCAC	Fink Jewelry Co., John, Fort Smith, Ark.	360
KFFP	First Baptist Church, Noberly, Mo.	275
KFDX	First Baptist Church, Shreveport, La.	360
WDAX	First National Bank, Centerville, Iowa	360
KFGX	First Presbyterian Church, Orange, Texas	250
KFBG	First Presbyterian Church, Tacoma, Wash.	360
KTW	First Presbyterian Church, Seattle, Wash.	360
WKAP	Flint, Dutee Wilcox, Cranston, R. I.	360
WDAL	Florida Times Union, Jacksonville, Fla.	360
KFCP	Flygare, Ralph W., Ogden, Utah	360
WWI	Ford Motor Co., Dearborn, Mich.	273
WPA	Fort Worth Record, Fort Worth, Texas	360
WIAJ	Fox River Valley Radio Supply Co., Neenah, Wis.	224
WSAL	Franklin Electrical Co., Brookville, Ind.	246
WABC	Fulwider-Grimes Battery Co., Anderson, Ind.	229
WIAC	Galveston Tribune, Galveston, Texas	360
WGAJ	Gass, W. H., Shenandoah, Iowa	360
WQAY	Gaston Music & Furniture Co., Hastings, Neb.	360
WGY	General Electric Co., Schenectady, N. Y.	380
WPAQ	General Sales & Engr. Co., Frostberg, Md.	360
WOAD	Friday Battery & Elect. Co., Sigourney, Iowa	360
WMAH	General Supply Co., Lincoln, Neb.	254
WAAS	Georgia Radio Co., Inc., Decatur, Ga.	360
KFDV	Gilbrech & Stinson, Fayetteville, Ark.	360
WAAK	Gimble Bros., Milwaukee, Wis.	280
WIP	Gimbel Bros., Philadelphia, Pa.	509
WQAC	Gish, E. B., Amarillo, Texas.	360
KFGY	Gjelhaug's Radio Shop, Baudette, Minn.	224
KDZX	Glad Tidings Tabernacle, San Francisco, Cal.	360
KJQ	Gould, C. O., Stockton, Cal.	360
KFFV	Graceland College, Lamoni, Iowa	360
WKAL	Gray & Gray, Orange, Texas	360
KNT	Gravs Harbor Radio Co., Aberdeen, Wash.	263
KFEJ	Greason, Guy, Tacoma, Wash.	360
WLAX	Greencastle Community Broadcasting Station, Greencastle, Ind.	231
WQAZ	Greensboro Daily News, Greensboro, N. C.	360
WSAJ	Grove City College, Grove City, Pa.	360
WHAH	Hafner Supply Co., Joplin, Mo.	360
WCBA	Haimbach, Chas. W., Allentown, Pa.	280
KPO	Hale Bros., Inc., San Francisco, Cal.	423
KGG	Hallock & Watson Radio Service, Portland, Ore.	360
WLK	Hamilton Mfg. Co., Indianapolis, Ind.	360
WOAT	Hamp, Boyd Martell, Wilmington, Del.	360

Call	Station	Wave-Lengths
WOAA	Hardy, Dr. Walter, Ardmore, Okla.	360
WDAK	Hartford Courant, Hartford, Conn.	261
KFDP	Hawkeye Radio Supply Co., Des Moines, Iowa	278
WEAS	Hecht Co., Washington, D. C.	360
WIAI	Heers Stores Co., Springfield, Mo.	360
KFGV	Heidbreder Radio Supply Co., Utica, Neb.	224
WEAD	Henry Radio & Elect. Supply, Atwood, Kan.	268
KXD	Herald Publishing Co., Modesto, Cal.	360
KQW	Herrold, Charles D., San Jose, Cal.	360
WFAJ	Hi Grade Wireless Inst. Co., Asheville, N. C.	360
WHAO	Hill, F. A., Savannah, Ga.	360
WAAZ	Hollister Miller Motor Co., Emporia, Kan.	360
KFBE	Horn, Reuben H., San Luis Obispo, Cal.	360
WJD	Howe, Richard Harris, Granville, Ohio	229
WGL	Howlette, Thomas F. J., Philadelphia, Pa.	360
WDAI	Hughes Electrical Corp., Syracuse, N. Y.	360
WQAV	Huntington & Guerry, Inc., Greenville, S. C.	360
WHAY	Huntington Press, Huntington, Ind.	360
WEV	Hurlburt-Still Electrical Co., Houston, Texas	360
WIAG	Huse Publishing Co., Norfolk, Neb.	360
WFAN	Hutchinson Elect. Service Co., Hutchinson, Minn.	360
WLAZ	Hutton & Jones Elect. Co., Warren, Ohio	248
WNAM	Ideal Apparatus Co., Evansville, Ind.	360
KFAU	Independent School District of Boise City, Boise, Idaho	270
WGV	Interstate Electric Co., New Orleans, La.	360
WOI	Iowa State College, Ames, Iowa	360
WFAY	Iris Theatre, Houston, Texas	360
KFDZ	Iverson, Harry C.	360
WJAD	Jackson's Radio Eng. Lab., Waco, Texas	360
WBAO	James Millikin University, Decatur, Ill.	360
WPAS	J. & M. Electric Co., Amsterdam, N. Y.	360
WSL	J. & M. Electric Co., Utica, N. Y.	273
KFIB	Jenkens, Franklin W., St. Louis, Mo.	244
KFFB	Jenkins Furniture Co., Boise, Idaho	360
WAAB	Jensen, Valdemar, New Orleans, La.	268
WLAP	Jordon, W. V., Louisville, Ky.	360
WIAB	Joslyn Automobile Co., Rockford, Ill.	360
WIAK	Journal Stockman Co., Omaha, Neb.	278
WOAP	Kalamazoo College, Kalamazoo, Mich.	360
WMAX	K. & K. Radio Supply Co., Ann Arbor, Mich.	360
WCBB	K. & K. Radio Supply Co., Greenville, Ohio	240
WIK	K. & L. Electric Co., McKeesport, Pa.	360
WDAF	Kansas City Star, Kansas City, Mo.	411
WTG	Kansas State Agricultural College, Manhattan, Kan.	360
WCAE	Kaufmann & Baer Co., Pittsburgh, Pa.	462
WJAT	Kelley-Vawter Jewelry Co., Marshall, Mo.	360
WJAP	Kelly-Duluth Co., Duluth, Minn.	360
WCAY	Kesselman O'Driscoll Co., Milwaukee, Wis.	261
KFBK	Kimbell-Upson Co., Sacramento, Cal.	360
WMAY	Kingshighway Presbyterian Church, St. Louis, Mo.	360
KFFR	Kirk, Jim, Sparks, Nev.	360
KFDL	Knight-Campbell Music Co., Denver, Colo.	360
WPAZ	Koch, John R., Charleston, W. Va.	273
WNAW	Kunzmann, Henry, Fort Monroe, Va.	360
WKAV	Laconia Radio Club, Laconia, N. H.	360
WABA	Lake Forest College, Lake Forest, Ill.	266
WABH	Lake Shore Tire Co., Sandusky, Ohio	249
WGAL	Lancaster Elect. Supply & Const. Co., Lancaster, Pa.	248
WHAL	Lansing Capitol News, Lansing, Mich.	248
KFIC	Laskowitz, Phillip, Denver, Colo.	224
WABB	Lawrence, Dr. John B., Harrisburg, Pa.	266
KFBL	Leese Bros., Everett, Wash.	224
KFGH	Leland Stanford Jr. Univ., Stanford Univ., Cal.	360
WNAT	Lennig Bros. Co., Philadelphia, Pa.	360
WSAH	Leonard, Jr., A. G., Chicago, Ill.	360
WGAU	Limb, Marcus G., Wooster, Ohio	226
KMC	Lindsay, W. W., Jr., Reedley, Cal.	360
WKAS	Lines Music Co., L. E., Springfield, Mo.	360
WDAR	Lit Bros., Philadelphia, Pa.	395
WGAN	Lloyd, Cecil E., Pensacola, Fla.	360
KFGB	Loewenthal Bros., Pueblo, Colo.	360
WRAM	Lombard College, Galesburg, Ill.	360
KWH	Los Angeles Examiner, Los Angeles, Cal.	360
KFCL	Los Angeles Union Stock Yards, Los Angeles, Cal.	360
KFGC	Louisiana State University, Baton Rouge, La.	254
KMO	Love Electric Co., Tacoma, Wash.	360
WWL	Loyola University, New Orleans, La.	360
WOAR	Lundskow, Henry P., Kenoska, Wis.	360
WOAO	Lyradion Mfg. Co., Mishawaka, Ind.	360
WKAX	Macfarlane, Wm. A., Bridgeport, Conn.	231
KFCV	Mahaffey, Jr., Fred, Houston, Texas	360
WBAW	Marietta College, Marietta, Ohio.	360
WWAY	Marigold Gardens, Chicago, Ill.	360
KFFQ	Marksheffel Motor Co., Colorado Springs, Colo.	360
WHAD	Marquette University, Milwaukee, Wis.	360
WDAG	Martin, J. Laurence, Amarillo, Texas	263
WOAC	Maus Radio Co., Lima, Ohio	266
WBS	May, D. W., Inc., Newark, N. J.	360
KFAD	McArthur Bros. Mercantile Co., Phoenix, Ariz.	360
WTP	McBride, George M., Bay City, Mich.	360
KFHH	McCue, Ambrose A., Neah Bay, Wash.	283
KFFX	McGraw Co., The, Omaha, Neb.	278
KFEC	Meier & Frank Co., Alder St., Portland, Ore.	360
KFDB	Mercantile Trust Co. of California, San Francisco, Cal.	509
WMAZ	Mercer University, Macon, Ga.	268
WOU	Metropolitan Utilities District, Omaha, Neb.	360
WFAW	Miami Daily Metropolis, Miami, Fla.	360
WKAR	Michigan Agricultural College, East Lansing, Mich.	360
WBAF	Middleton, Fred M., Moorestown, N. J.	360
WOAE	Midland College, Fremont, Neb.	360
WDAP	Midwest Radio Central, Inc., Chicago, Ill.	360
WOS	Missouri State Marketing Bureau, Jefferson City, Mo.	360
WFAQ	Missouri Wesleyan College and The Cameron Radio Co., Cameron, Mo.	360
WEAP	Mobile Radio Co., Inc., Mobile, Ala.	360
KFCF	Moore, Frank A., Walla Walla, Wash.	360
WQAE	Moore Radio News Station, Springfield, Vt.	360
KFCQ	Motor Service Station, Casper, Wyo.	360
WABF	Mt. Vernon Register News Co., Mt. Vernon, Ill.	234
KGB	Mullins Elect. Co., Wm. A., Tacoma, Wash.	360
KGU	Mulrony, Marion A., Honolulu, Hawaii	360
KFGJ	National Guards Missouri, St. Louis, Mo.	266
KFDU	Nebraska Radio Elect. Co., Lincoln, Neb.	360
WCAJ	Nebraska Wesleyan University (Lincoln, Neb.), University Place, Neb.	360
WAAM	Nelson Co., I. R., Newark, N. J.	263
KDZK	Nevada Machinery & Elect. Co., Reno, Nev.	360
WBBA	Newark Radio Lab., Newark, Ohio.	240
WCAB	Newburgh News Printing & Pub. Co., Newburgh, N. Y.	360
KOB	New Mexico College of Agriculture & Mech. Arts, State College, N. M.	360
WLAW	New York Police Dept., New York, N. Y.	360
WIAV	New York Radio Laboratories, Binghampton, N. Y.	360
WEAG	Nichols Hineline Bassett Lab., Edgewood, R. I.	231
KFCB	Nielsen Radio Supply Co., Phoenix, Ariz.	360
WIAT	Noel, Leon T., Tarkio, Mo.	360
WLAC	North Carolina State College, Raleigh, N. C.	360
KFIO	North Central High School, Spokane, Wash.	252
WPAK	North Dakota Agri. College, Agricultural College, N. D.	360
WEAM	North Plainfield, Borough of N. Plainfield, N. J.	252
WLAY	Northern Commercial Co. of Alaska	360
WRAL	Northern States Power Co., St. Crois Falls, Wis.	248
KJR	Northwest Radio Service Co., Seattle, Wash.	270
WGAY	North Western Radio Co., Inc., Madison, Wis.	360
KGN	Northwestern Radio Mfg. Co., Portland, Ore.	360
WMAK	Norton Laboratories, Lockport, N. Y.	360
WPG	Nushawg Poultry Farm, New Lebanon, Ohio	360
WIAD	Ocean City Yacht Club, Ocean City, N. J.	254
WAAD	Ohio Mechanics Institute, Cincinnati, Ohio	360
WEAO	Ohio State University, Columbus, Ohio	360
WKAK	Okfuskee County News, Okemah, Okla.	360
KFAR	Olessen, O. K., Hollywood, Cal.	360
KFCZ	Omaha Central High School, Omaha, Neb.	360
WAAW	Omaha Grain Exchange, Omaha, Neb.	360
WGAM	Orangeburg Radio Equipt. Co., Orangeburg, S. C.	360
KFDJ	Oregon Agri. College, Corvallis, Ore.	360
KDYQ	Oregon Institute of Tech., Portland, Ore.	360
WHAP	Otta & Kuhms, Decatur, Ill.	360
WJAH	Outlet Co., The, Providence, R. I.	360
WKAA	Paar, H. F., & Republican Times, Cedar Rapids, Iowa	360
WIAR	Paducah Evening Sun, Paducah, Ky.	360
WMAC	Page, J. Edward, Cazenovia, N. Y.	360
WOC	Palmer School of Chiropractic, Davenport, Iowa	484
WOAH	Palmetto Radio Corp., Charleston, S. C.	360
WMAT	Paramount Radio Corp., Duluth, Minn.	360
WNAB	Park City Daily News, Bowling Green, Ky.	360
WABD	Parker High School, Dayton, Ohio.	283
WGAQ	Patterson, W. G., Shreveport, La.	360
WOAZ	Penick-Hughes Co., Stamford, Texas	360
KFHL	Penn College, Oskaloosa, Iowa	227
WOAV	Pennsylvania National Guard, Erie, Pa.	242
WPAB	Pennsylvania State College, State College, Pa.	360
WBAK	Pennsylvania State Police Dept. of Harrisburg, Pa.	360
WTAC	Penn. Traffic Co., Johnstown, Pa.	360
WNAV	Peoples Tel. & Tel. Co., Knoxville, Tenn.	360
WJAN	Peoria Star Co., Peoria, Ill.	280
WIAM	Perham, D. M., Cedar Rapids, Iowa	360
WPAF	Peterson's Radio Co., Council Bluffs, Iowa	360
WPAP	Phillips, Theodore D., Winchester, Ky.	360
KDZG	Pierce & Co., Cyrus, San Francisco, Cal.	360
WHAW	Pierce Elect. Co., Tampa, Fla.	360
KFFY	Pincus & Murphy, Inc., Alexandria, La.	275
WOK	Pine Bluff Co., The, Pine Bluff, Ark.	360
WJAS	Pittsburgh Radio Supply House, Pittsburgh, Pa.	360
WKAH	Planet Radio Co., West Palm Beach, Fla.	360
KWG	Portable Wireless Telephone Co., Stockton, Cal.	360
KGW	Portland Oregonian, Portland, Ore.	492
WOAQ	Portsmouth Kiwanis Club, Portsmouth, Va.	360
WMH	Precision Equipment Co., Cincinnati, Ohio	248
WOAR	Press Publishing Co., Muncie, Ind.	360
KSS	Prest & Dean Radio Research Laboratory, Long Beach, Cal.	360
WOAS	Prince Walter Co., Lowell, Mass.	266
KSD	Pulitzer Publishing Co., St. Louis, Mo.	546
WBAA	Purdue University, W. Lafayette, Ind.	360
WLAN	Putnam Hardware Co., Houlton, Me.	360
KDZO	Pyle & Nichols, Denver, Colo.	360
WCAW	Quincy Electric Supply Co., Quincy, Ill.	360
WLAT	Radio and Specialty Co., Burlington, Iowa	360
KFHP	Radio Bug Products Co., Kearney, Neb.	246
WRAF	Radio Club, Inc., Laporte, Ind.	224
WIY	Radio Corp. of America, New York	405
WIZ	Radio Corp. of America, New York	455
WKAQ	Radio Corp. of America, San Juan, P. R.	360
KFAW	Radio Den, The, Santa Ana, Cal.	360
WGAX	Radio Elec. Co., Washington C. H., Ohio	360
KFEV	Radio Elec. Shop, Douglas, Wyo.	263
WFAG	Radio Engineering Lab., Waterford, N. Y.	360
WHAI	Radio Equipment & Mfg. Co., Davenport, Iowa	360
KFEP	Radio Equipment Co. (Jos. L. Turre), Denver, Colo.	240
WQAX	Radio Equipment Co., Peoria, Ill.	360
WQAT	Radio Equipment Corp., Westhampton, Va.	360
WRAY	Radio Sales Corp., Scranton, Pa.	360
WRAO	Radio Service Co., St. Louis, Mo.	360
KII	Radio Shop, The, Sunnyvale, Cal.	360
WKY	Radio Shop, Oklahoma City, Okla.	360
WRAS	Radio Supply Co., McLeansboro, Ill.	360
WMAB	Radio Supply Co., Oklahoma City, Okla.	360
KFDC	Radio Supply Co., Spokane, Wash.	360
KNV	Radio Supply Co. of Cal., Los Angeles, Cal.	360
WRAH	Read, Stanley N., Providence, R. I.	360
WGF	Register & Tribune, Des Moines, Iowa	360
WHAZ	Rennselaer Polytechnic Inst., Troy, N. Y.	380
WBAU	Republican Publishing Co., Hamilton, Ohio	258
KLZ	Reynolds Radio Co., Inc., Denver, Colo.	360
WNAR	Rhodes, C. C., Butler, Mo.	360
KDZE	Rhodes Co., The, Seattle, Wash.	360
WRAA	Rice Institute, Houston, Tex.	360
KFCM	Richmond Radio Shop, Richmond, Cal.	360
WKN	Riechman-Crosby Co., The, Memphis, Tenn.	360

Revised List of Broadcasting Stations with New Wave-Lengths to June 8th

Call	Station	Wave-Lengths
KFAV	Abbot Kinney Co., Venice, Cal.	258
WEAK	Abercrombie, Julius B., St. Joseph, Mo.	360
KFDA	Adler's Music Store, Baker, Ore.	360
WTAW	Agricultural & Mechanical College of Texas, College Station, Tex.	360
WMAV	Alabama Polytechnic Inst., Auburn, Ala.	250
WSY	Alabama Power Co., Birmingham, Ala.	360
WCAR	Alamo Radio Elect. Co., San Antonio, Texas	360
WGAW	Albright, Ernest C., Altoona, Pa.	261
KZM	Allen, Preston D., Oakland, Cal.	360
KGO	Altadena Radio Lab., Altadena, Cal.	360
WRAU	Amarillo Daily News, Amarillo, Tex.	360
WJAB	American Radio Co., Lincoln, Neb.	360
WG-	American Radio & Research Corp., Medford Hillside, Mass.	360
KFEZ	American Society of Mech. Engrs., St. Louis, Mo.	360
WEAF	American Telephone & Telegraph Co., New York, N. Y.	492
WIAU	American Trust & Savings Bank, Le Mars, Iowa	360
WPAA	Anderson & Webster Elect. Co., Wahoo, Neb.	360
WRAV	Antioch College, Yellow Springs, Ohio	360
WQAJ	Ann Arbor Times News, Ann Arbor, Mich.	360
KFI	Anthony, Earle C. Inc., Los Angeles, Cal.	469
WOAG	Apollo Theatre, Belvidere, Ill.	224
WQAK	Appel-Higley Elect. Co., Dubuque, Iowa	360
KQP	Apple City Radio Club, Hood River, Ore.	360
WFAT	Argus-Leader, Sioux Falls, S. D.	360
KFGL	Arlington Garage, Arlington, Ore.	234
WABG	Arnold Edwards Piano Co., Jacksonville, Fla.	248
WMAD	Atchison County Mail, Rockport, Mo.	360
WGM	Atlanta Constitution, Atlanta, Ga.	429
WSB	Atlanta Journal Co., Atlanta, Ga.	429
WDAJ	Atlanta & West Point R. R. Co., College Park, Ga.	360
WPAM	Auerbach & Guettel, Topeka, Kan.	360
KFEX	Augsburg Seminary, Minneapolis, Minn.	261
KFER	Auto Electric Service Co., Ft. Dodge, Iowa	231
KDZF	Automobile Club of So. Calif., Los Angeles, Calif.	278
WDAO	Automotive Electric Co., Dallas, Texas	360
WHAE	Automotive Electric Service Co., Sioux City, Iowa	360
KFBC	Azbill, W. K., San Diego, Calif.	360
WOAS	Bailey's Radio Shop, Middletown, Conn.	360
WEAR	Baltimore American & News Publishing Co., Md.	360
WOR	Bamberger, L. & Co., Newark, N. J.	405
WPAY	Bangor Radio Lab., Bangor, Me.	360
WABI	Bangor Ry. & El. Co., Bangor Me.	240
WBBD	Barbey Battery Service, Reading, Pa.	224
KFFZ	Barnes Amusement Co., Al. G., Dallas, Texas	226
WQAA	Beale, Horace A., Jr., Parkesburg, Pa.	360
WAAL	Beamish Elect. Co., Minneapolis, Minn.	360
WMAM	Beaumont Radio Equipment Co., Beaumont, Tex.	360
KDZR	Bellingham Publishing Co., Bellingham, Wash.	261
KFIF	Benson Tech. Student Body, Portland, Ore.	360
WEB	Benwood Company, Inc., The, St. Louis, Mo.	360
KRE	Berkeley Gazette, Berkeley, Cal.	360
KJS	Bible Institute of Los Angeles, Cal.	360
WRAN	Black Hawk Electrical Co., Waterloo, Iowa	229
KFHB	Boardwell, P. L., Hood River, Ore.	280
WKAV	Brennan College, Gainesville, Ga.	360
WMAN	Broad St. Baptist Church, Columbus, Ohio	360
WQAH	Brook-Anderson Elect. Eng. Co., Lexington, Ky.	254
KNX	Bullock's, Los Angeles, Cal.	360
KFDR	Bullock's Hardware & Sporting Goods, York, Neb.	360
KFEY	Bunker Hill & Sullivan Mining & Const. Co., Kellog, Idaho	360
WIAS	Burlington Hawk-Eye Home Elect. Co., Burlington, Iowa	360
WDZ	Bush, James L., Tuscola, Ill.	278
KFBB	Buttrey & Co., F. A. Havre, Mont.	360
WQAO	Calvary Baptist Church, New York, N. Y.	360
WJAQ	Capper Publications, Topeka, Kan.	360
KFDF	Casper Community Radio Corp., Casper, Wyo.	360
WQAW	Catholic University of America, Washington, D. C.	360
KFHF	Central Christian Church, Shreveport, La.	266
WDAD	Central Kansas Radio Supply, Linsborg, Kan.	360
WPE	Central Radio Co., Inc., Independence, Mo.	360
WLAS	Central Radio Supply Co., Hutchinson, Kan.	244
WNAQ	Charleston Radio Elect. Co., Charleston, S. C.	360
KFGP	Cheney Radio Co., Cheney, Kan.	229
WAAF	Chicago Daily Drovers Journal, Chicago, Ill.	286
WMAQ	Chicago Daily News, Chicago, Ill.	448
WJAZ	Chicago Radio Laboratory, Chicago, Ill.	448
KFGD	Chickasha Radio & Elect. Co., Chickasha, Okla.	248
KFBS	Chronicle News, Gas & Electric Supply Co., Trinidad, Colo.	360
WIAQ	Chronicle Publishing Co., Marion, Ind.	360
WDM	Church of the Covenant, Washington, D. C.	360
WIZ	Cino Radio Mfg. Co., The, Cincinnati, Ohio	360
KUS	City Dye Works & Laundry Co., Los Angeles, Cal.	360
WBU	City of Chicago, Chicago, Ill.	286
WRR	City of Dallas, Police & Fire Signal Dept., Dallas, Texas	360
KFAQ	City of San Jose, San Jose, Cal.	360
KFEB	City of Taft, Taft, Cal.	360
WON	Clark University, Worcester, Mass.	360
WSAC	Clemson Agricultural College, Clemson College, S. C.	360
KUY	Coast Radio Co., El Monte, Cal.	360
WHAC	Cole Bros. Elect. Co., Waterloo, Iowa	360
WQAL	Cole County Tel. & Tel. Co., Mattoon, Ill.	360
WOAK	Collins' Hardware Co., Frankfort, Ky.	360
KFCK	Colorado Springs Radio Co. Colorado Springs, Colo.	360
KFHA	Colorado State Normal School, Gunnison, Colo.	360
WMC	Commercial Publishing Co., Memphis, Tenn.	500
WAAH	Commonwealth Electric Co., Inc., St. Paul, Minn.	360
WCAZ	Compton, Robt. E., & Carthage College, Carthage, Ill.	360
WPAU	Concordia College, Moorhead, Minn.	360
WIL	Continental Electric Supply Co., Washington, D. C.	360
WIAH	Continental Radio Mfg. Co., Newton, Iowa	360
WEAI	Cornell University, Ithaca, N. Y.	286
WEY	Cosradio Company, The, Wichita, Kan.	360
WHAS	Courier Journal & Louisville Times, Louisville, Ky.	400
WHK	Cox, Warren R., Cleveland, Ohio	360
KFGQ	Crary Hardware Co., Boone, Iowa	226
WLW	Crosley Manufacturing Co., Cincinnati, Ohio	360
KFDO	Cutting, H. E., Bozeman, Mont.	248
WLAG	Cutting & Washington Radio Corp., Minneapolis, Minn.	417
WWB	Daily News Printing Co., The, Canton, Ohio	360
WCAG	Daily States Pub. Co., New Orleans, La.	360
WNAX	Dakota Radio Apparatus Co., Yankton, S. D.	244
WFAA	Dallas News & Dallas Journal, Dallas, Texas	476
WEAX	Daly, T. J. M., (Argenta), Little Rock, Ark.	360
WCAK	Daniel, Alfred P., Houston, Texas	360
WEAU	Davidson Bros. Co., Sioux City, Iowa	360
WBAH	Dayton Co., The, Minneapolis, Minn.	360
WIAF	De Cortin, Gustave A., New Orleans, La.	360
WJX	De Forest Radio Tel. & Tel. Co., New York City	360
KFKH	Denver Park Amusement Co., Lakeside, Colo.	226
KZN	Desert News, The, Salt Lake City, Utah	360
WCX	Detroit Free Press, Detroit, Mich.	517
KOP	Detroit Police Dept., Detroit, Mich.	286
WCAV	Dice Electric Co., J. C., Little Rock, Ark.	360
KFHI	Dixon, Charles V., Wichita, Kan.	224
KFZ	Doerr Mitchell Elect. Co., Spokane, Wash.	283
WPAC	Donaldson Radio Co., Okmulgee, Okla.	360
KFAT	Donohue, Dr. S. T., Eugene, Ore.	275
WPAJ	Doolittle Radio Corp., New Haven, Conn.	268
WRK	Doron Brothers Electric Co., Hamilton, Ohio	360
KQV	Doubleday-Hill Electric Co., Pittsburgh, Pa.	360
WMU	Doubleday-Hill Electric Co., Washington, D. C.	261
WMAJ	Drovers Telegram Co., Kansas City, Mo.	275
WCAS	Dunwoody, Wm. Hood Industrial Inst., Minneapolis, Minn.	360
WCAU	Durham & Co., Philadelphia, Pa.	286
KFFE	Eastern Oregon Radio Co., Pendleton, Ore.	360
WRAK	Economy Light Co., Escanaba, Mich.	360
KMX	Electric Lighting Supply Co., Los Angeles, Cal.	360
KFCH	Electric Service Station, Billings, Mont.	360
KYO	Electric Shop, Honolulu, T. H.	360
KFAN	Electric Shop, Moscow, Idaho	360
WLAV	Electric Shop, Inc., Pensacola, Fla.	360
WPI	Electric Supply Co., Clearfield, Pa.	360
WFAH	Electric Supply Co., Port Arthur, Texas	360
KDZI	Electric Supply Co., Wenatchee, Wash.	360
WQAM	Electrical Equipment Co., Miami, Fla.	360
KFGZ	Emmanuel Missionary College, Berrien Springs, Mich.	268
KSL	Emporium, The, San Francisco, Cal.	360
WCAH	Entrekin Electric Co., Columbus, Ohio	286
WTAS	Erbstein, Charles E., Elgin, Ill.	275
WBAV	Erner & Hopkins Co., The, Columbus, Ohio	360
WOAJ	Ervins Electrical Co., Parsons, Kan.	360
WWJ	Evening News Assn., Detroit News, Detroit, Mich.	517
KUO	Examiner Printing Co., The, San Francisco, Cal.	360
WEAA	Fallain & Lathrop, Flint, Mich.	360
KFHJ	Fallon Co., Santa Barbara, Cal.	360
WDAY	Fargo Radio Service Co., Fargo, N. D.	244
WRP	Federal Institute of Radio Telegraphy, Camden, N. J.	360
WGR	Federal Tel. & Tel. Co., Buffalo, N. Y.	360
WCE	Findley Electric Co., Inc., Minneapolis, Minn.	360
WCAC	Fink Jewelry Co., John, Fort Smith, Ark.	360
KFFP	First Baptist Church, Noberly, Mo.	275
KFDX	First Baptist Church, Shreveport, La.	360
WDAX	First National Bank, Centerville, Iowa	360
KFGX	First Presbyterian Church, Orange, Texas	250
KFBG	First Presbyterian Church, Tacoma, Wash.	360
KTW	First Presbyterian Church, Seattle, Wash.	360
WKAP	Flint, Dutee Wilcox, Cranston, R. I.	360
WDAL	Florida Times Union, Jacksonville, Fla.	360
KFCP	Flygare, Ralph W., Ogden, Utah	360
WWI	Ford Motor Co., Dearborn, Mich.	273
WPA	Fort Worth Record, Fort Worth, Texas	360
WIAJ	Fox River Valley Radio Supply Co., Neenah, Wis.	224
WSAL	Franklin Electrical Co., Brookville, Ind.	246
WABC	Fulwider-Grimes Battery Co., Anderson, Ind.	229
WIAC	Galveston Tribune, Galveston, Texas	360
WGAJ	Gass, W. H., Shenandoah, Iowa	360
WQAY	Gaston Music & Furniture Co., Hastings, Neb.	360
WGY	General Electric Co., Schenectady, N. Y.	380
WPAQ	General Sales & Engr. Co., Frostberg, Md.	360
WOAD	Friday Battery & Elect. Co., Sigourney, Iowa	360
WMAH	General Supply Co., Lincoln, Neb.	254
WAAS	Georgia Radio Co., Inc., Decatur, Ga.	360
KFDV	Gilbrech & Stinson, Fayetteville, Ark.	360
WAAK	Gimble Bros., Milwaukee, Wis.	280
WIP	Gimbel Bros., Philadelphia, Pa.	509
WQAC	Gish, E. B., Amarillo, Texas	360
KFGY	Gjelhaug's Radio Shop, Baudette, Minn.	224
KDZX	Glad Tidings Tabernacle, San Francisco, Cal.	360
KJQ	Gould, C. O., Stockton, Cal.	360
KFFV	Graceland College, Lamoni, Iowa	360
WKAL	Gray & Gray, Orange, Texas	360
KNT	Grays Harbor Radio Co., Aberdeen, Wash.	263
KFEJ	Greason, Guy, Tacoma, Wash.	360
WLAX	Greencastle Community Broadcasting Station, Greencastle, Ind.	231
WQAZ	Greensboro Daily News, Greensboro, N. C.	360
WSAJ	Grove City College, Grove City, Pa.	360
WHAH	Hafner Supply Co., Joplin, Mo.	360
WCBA	Haimbach, Chas. W., Allentown, Pa.	280
KPO	Hale Bros., Inc., San Francisco, Cal.	423
KGG	Hallock & Watson Radio Service, Portland, Ore.	360
WLK	Hamilton Mfg. Co., Indianapolis, Ind.	360
WOAT	Hamp, Boyd Martell, Wilmington, Del.	360

Call	Station	Wave-Lengths
WOAA	Hardy, Dr. Walter, Ardmore, Okla.	360
WDAK	Hartford Courant, Hartford, Conn.	261
KFDP	Hawkeye Radio Supply Co., Des Moines, Iowa	278
WEAS	Hecht Co., Washington, D. C.	360
WIAI	Heers Stores Co., Springfield, Mo.	360
KFGV	Heidbreder Radio Supply Co., Utica, Neb.	224
WEAD	Henry Radio & Elect. Supply, Atwood, Kan.	268
KXD	Herald Publishing Co., Modesto, Cal.	360
KQW	Herrold, Charles D., San Jose, Cal.	360
WFAJ	Hi Grade Wireless Inst. Co., Asheville, N. C.	360
WHAQ	Hill, F. A., Savannah, Ga.	360
WAAZ	Hollister Miller Motor Co., Emporia, Kan.	360
KFBE	Horn, Reuben H., San Luis Obispo, Cal.	360
WJD	Howe, Richard Harris, Granville, Ohio	229
WGL	Howlette, Thomas F. J., Philadelphia, Pa.	360
WDAI	Hughes Electrical Corp., Syracuse, N. Y.	360
WQAV	Huntington & Guerry, Inc., Greenville, S. C.	360
WHAY	Huntington Press, Huntington, Ind.	360
WEV	Hurlburt-Still Electrical Co., Houston, Texas	360
WIAG	Huse Publishing Co., Norfolk, Neb.	360
WFAN	Hutchinson Elect. Service Co., Hutchinson, Minn.	360
WLAZ	Hutton & Jones Elect. Co., Warren, Ohio	248
WNAM	Ideal Apparatus Co., Evansville, Ind.	360
KFAU	Independent School District of Boise City, Boise, Idaho	270
WGV	Interstate Electric Co., New Orleans, La.	360
WOI	Iowa State College, Ames, Iowa	360
WFAY	Iris Theatre, Houston, Texas	360
KFDZ	Iverson, Harry C.	360
WJAD	Jackson's Radio Eng. Lab., Waco, Texas	360
WBAO	James Millikin University, Decatur, Ill.	360
WPAS	J. & M. Electric Co., Amsterdam, N. Y.	360
WSL	J. & M. Electric Co., Utica, N. Y.	273
KFIB	Jenkens, Franklin W., St. Louis, Mo.	244
KFFR	Jenkins Furniture Co., Boise, Idaho	360
WAAB	Jensen, Valdemar, New Orleans, La.	268
WLAP	Jordon, W. V., Louisville, Ky.	360
WIAB	Joslyn Automobile Co., Rockford, Ill.	360
WIAK	Journal Stockman Co., Omaha, Neb.	278
WOAP	Kalamazoo College, Kalamazoo, Mich.	360
WMAX	K. & K. Radio Supply Co., Ann Arbor, Mich.	360
WCBB	K. & K. Radio Supply Co., Greenville, Ohio	240
WJK	K. & L. Electric Co., McKeesport, Pa.	360
WDAF	Kansas City Star, Kansas City, Mo.	411
WTG	Kansas State Agricultural College, Manhattan, Kan.	360
WCAE	Kaufmann & Baer Co., Pittsburgh, Pa.	462
WJAT	Kelley-Vawter Jewelry Co., Marshall, Mo.	360
WIAP	Kelly-Duluth Co., Duluth, Minn.	360
WCAY	Kesselman O'Driscoll Co., Milwaukee, Wis.	261
KFBK	Kimbell-Upson Co., Sacramento, Cal.	360
WMAY	Kingshighway Presbyterian Church, St. Louis, Mo.	360
KFFR	Kirk, Jim, Sparks, Nev.	360
KFDL	Knight-Campbell Music Co., Denver, Colo.	360
WPAZ	Koch, John R., Charleston, W. Va.	273
WNAW	Kunzmann, Henry, Fort Monroe, Va.	360
WKAV	Laconia Radio Club, Laconia, N. H.	360
WABA	Lake Forest College, Lake Forest, Ill.	266
WABH	Lake Shore Tire Co., Sandusky, Ohio	240
WGAL	Lancaster Elect. Supply & Const. Co., Lancaster, Pa.	248
WHAL	Lansing Capitol News, Lansing, Mich.	248
KFIC	Laskowitz, Phillip, Denver, Colo.	224
WABB	Lawrence, Dr. John B., Harrisburg, Pa.	266
KFBI	Leese Bros., Everett, Wash.	224
KFGH	Leland Stanford Jr. Univ., Stanford Univ., Cal.	360
WNAT	Lennig Bros. Co., Philadelphia, Pa.	360
WSAH	Leonard, Jr., A. G., Chicago, Ill.	360
WGAU	Limb, Marcus G., Wooster, Ohio	226
KMC	Lindsay, W. W., Jr., Reedley, Cal.	360
WKAS	Lines Music Co., L. E., Springfield, Mo.	360
WDAR	Lit Bros., Philadelphia, Pa.	395
WGAN	Lloyd, Cecil E., Pensacola, Fla.	360
KFGB	Loewenthal Bros., Pueblo, Colo.	360
WRAM	Lombard College, Galesburg, Ill.	360
KWH	Los Angeles Examiner, Los Angeles, Cal.	360
KFCL	Los Angeles Union Stock Yards, Los Angeles, Cal.	360
KFGC	Louisiana State University, Baton Rouge, La.	254
KMO	Love Electric Co., Tacoma, Wash.	360
WWL	Loyola University, New Orleans, La.	360
WOAR	Lundskow, Henry P., Kenoska, Wis.	360
WOAO	Lyradion Mfg. Co., Mishawaka, Ind.	360
WKAX	Macfarlane, Wm. A., Bridgeport, Conn.	231
KFCV	Mahaffey, Jr., Fred, Houston, Texas	360
WBAW	Marietta College, Marietta, Ohio	360
WWAV	Marigold Gardens, Chicago, Ill.	360
KFFQ	Marksheffel Motor Co., Colorado Springs, Colo.	360
WHAD	Marquette University, Milwaukee, Wis.	360
WDAG	Martin, J. Laurence, Amarillo, Texas	263
WOAC	Maus Radio Co., Lima, Ohio	266
WBS	May, D. W., Inc., Newark, N. J.	360
KFAD	McArthur Bros. Mercantile Co., Phoenix, Ariz.	360
WTP	McBride, George M., Bay City, Mich.	360
KFHH	McCue, Ambrose A., Neah Bay, Wash.	283
KFFX	McGraw Co., The, Omaha, Neb.	278
KFEC	Meier & Frank Co., Alder St., Portland, Ore.	360
KFDB	Mercantile Trust Co. of California, San Francisco, Cal.	509
WMAZ	Mercer University, Macon, Ga.	268
WOC	Metropolitan Utilities District, Omaha, Neb.	360
WFAW	Miami Daily Metropolis, Miami, Fla.	360
WKAR	Michigan Agricultural College, East Lansing, Mich.	360
WBAF	Middleton, Fred M., Moorestown, N. J.	360
WOAE	Midland College, Fremont, Neb.	360
WDAP	Midwest Radio Central, Inc., Chicago, Ill.	360
WOS	Missouri State Marketing Bureau, Jefferson City, Mo.	360
WFAQ	Missouri Wesleyan College and The Cameron Radio Co., Cameron, Mo.	360
WEAP	Mobile Radio Co., Inc., Mobile, Ala.	360
KFCF	Moore, Frank A., Walla Walla, Wash.	360
WOAE	Moore Radio News Station, Springfield, Vt.	360
KFCQ	Motor Service Station, Casper, Wyo.	360
WABF	Mt. Vernon Register News Co., Mt. Vernon, Ill.	234
KGB	Mullins Elect. Co., Wm. A., Tacoma, Wash.	360
KGU	Mulrony, Marion A., Honolulu, Hawaii	360
KFGJ	National Guards Missouri, St. Louis, Mo.	266
KFDU	Nebraska Radio Elect. Co., Lincoln, Neb.	360
WCAJ	Nebraska Wesleyan University (Lincoln, Neb.), University Place, Neb.	360
WAAM	Nelson Co., I. R., Newark, N. J.	263
KDZK	Nevada Machinery & Elect. Co., Reno, Nev.	360
WBBA	Newark Radio Lab., Newark, Ohio	240
WCAB	Newburgh News Printing & Pub. Co., Newburgh, N. Y.	360
KOB	New Mexico College of Agriculture & Mech. Arts, State College, N. M.	360
WLAW	New York Police Dept., New York, N. Y.	360
WIAV	New York Radio Laboratories, Binghamton, N. Y.	360
WEAG	Nichols Hineline Bassett Lab., Edgewood, R. I.	231
KFCB	Nielsen Radio Supply Co., Phoenix, Ariz.	360
WIAT	Noel, Leon T., Tarkio, Mo.	360
WLAC	North Carolina State College, Raleigh, N. C.	360
KFIO	North Central High School, Spokane, Wash.	252
WPAK	North Dakota Agri. College, Agricultural College, N. D.	360
WEAM	North Plainfield, Borough of N. Plainfield, N. J.	252
WLAV	Northern Commercial Co. of Alaska	360
WRAL	Northern States Power Co., St. Crois Falls, Wis.	248
KIR	Northwest Radio Service Co., Seattle, Wash.	270
WGAY	North Western Radio Co., Inc., Madison, Wis.	360
KGN	Northwestern Radio Mfg. Co., Portland, Ore.	360
WMAK	Norton Laboratories, Lockport, N. Y.	360
WPG	Nushawg Poultry Farm, New Lebanon, Ohio	360
WIAD	Ocean City Yacht Club, Ocean City, N. J.	254
WAAD	Ohio Mechanics Institute, Cincinnati, Ohio	360
WEAO	Ohio State University, Columbus, Ohio	360
WKAK	Okfuskee County News, Okemah, Okla.	360
KFAR	Olessen, O. K., Hollywood, Cal.	360
KFCZ	Omaha Central High School, Omaha, Neb.	360
WAAW	Omaha Grain Exchange, Omaha, Neb.	360
WGAM	Orangeburg Radio Equipt. Co., Orangeburg, S. C.	360
KFDJ	Oregon Agri. College, Corvallis, Ore.	360
KDYQ	Oregon Institute of Tech., Portland, Ore.	360
WHAP	Otta & Kuhns, Decatur, Ill.	360
WJAH	Outlet Co., The, Providence, R. I.	360
WKAA	Paar, H. F., & Republican Times, Cedar Rapids, Iowa	360
WIAR	Paducah Evening Sun, Paducah, Ky.	360
WMAC	Page, J. Edward, Cazenovia, N. Y.	360
WOC	Palmer School of Chiropractic, Davenport, Iowa	484
WOAH	Palmetto Radio Corp., Charleston, S. C.	360
WMAT	Paramount Radio Corp., Duluth, Minn.	360
WNAB	Park City Daily News, Bowling Green, Ky.	360
WABD	Parker High School, Dayton, Ohio	283
WGAQ	Patterson, W. G., Shreveport, La.	360
WOAZ	Penick Hughes Co., Stamford, Texas	360
KFHL	Penn College, Oskaloosa, Iowa	227
WOAV	Pennsylvania National Guard, Erie, Pa.	242
WPAB	Pennsylvania State College, State College, Pa.	360
WBAK	Pennsylvania State Police Dept. of Harrisburg, Pa.	360
WTAC	Penn. Traffic Co., Johnstown, Pa.	360
WNAV	Peoples Tel. & Tel. Co., Knoxville, Tenn.	360
WIAN	Peoria Star Co., Peoria, Ill.	280
WIAM	Perham, D. M., Cedar Rapids, Iowa	360
WPAF	Peterson's Radio Co., Council Bluffs, Iowa	360
WPAP	Phillips, Theodore D., Winchester, Ky.	360
KDZG	Pierce & Co., Cyrus, San Francisco, Cal.	360
WHAW	Pierce Elect. Co., Tampa, Fla.	360
KFFY	Pincus & Murphy, Inc., Alexandria, La.	275
WOK	Pine Bluff Co., The, Pine Bluff, Ark.	360
WJAS	Pittsburgh Radio Supply House, Pittsburgh, Pa.	360
WKAH	Planet Radio Co., West Palm Beach, Fla.	360
KWG	Portable Wireless Telephone Co., Stockton, Cal.	360
KGW	Portland Oregonian, Portland, Ore.	492
WOAQ	Portsmouth Kiwanis Club, Portsmouth, Va.	360
WMH	Precision Equipment Co., Cincinnati, Ohio	248
WOAR	Press Publishing Co., Muncie, Ind.	360
KSS	Prest & Dean Radio Research Laboratory, Long Beach, Cal.	360
WOAS	Prince Walter Co., Lowell, Mass.	266
KSD	Pulitzer Publishing Co., St. Louis, Mo.	546
WBAA	Purdue University, W. Lafayette, Ind.	360
WLAN	Putnam Hardware Co., Houlton, Me.	360
KDZO	Pyle & Nichols, Denver, Colo.	360
WCAW	Quincy Electric Supply Co., Quincy, Ill.	360
WLAT	Radio and Specialty Co., Burlington, Iowa	360
KFHP	Radio Bug Products Co., Kearney, Neb.	246
WRAF	Radio Club, Inc., Laporte, Ind.	224
WIY	Radio Corp. of America, New York	405
WIZ	Radio Corp. of America, New York	455
WKAQ	Radio Corp. of America, San Juan, P. R.	360
KFAW	Radio Den, The, Santa Ana, Cal.	360
WGAX	Radio Elec. Co., Washington C. H., Ohio	360
KFEV	Radio Elec. Shop, Douglas, Wyo.	263
WFAG	Radio Engineering Lab., Waterford, N. Y.	360
WHAI	Radio Equipment & Mfg. Co., Davenport, Iowa	360
KFEP	Radio Equipment Co. (Jos. L. Turre), Denver, Colo.	240
WQAX	Radio Equipment Co., Peoria, Ill.	360
WQAT	Radio Equipment Corp., Westhampton, Va.	360
WRAV	Radio Sales Corp., Scranton, Pa.	360
WRAO	Radio Service Co., St. Louis, Mo.	360
KII	Radio Shop, The, Sunnyvale, Cal.	360
WKY	Radio Shop, Oklahoma City, Okla.	360
WRAS	Radio Supply Co., McLeansboro, Ill.	360
WMAB	Radio Supply Co., Oklahoma City, Okla.	360
KFDC	Radio Supply Co., Spokane, Wash.	360
KNV	Radio Supply Co. of Cal., Los Angeles, Cal.	360
WRAH	Read, Stanley N., Providence, R. I.	360
WGF	Register & Tribune, Des Moines, Iowa	360
WHAZ	Rennselaer Polytechnic Inst., Troy, N. Y.	380
WBAU	Republican Publishing Co., Hamilton, Ohio	258
KLZ	Reynolds Radio Co., Inc., Denver, Colo.	360
WNAR	Rhodes, C. C., Butler, Mo.	360
KDZE	Rhodes Co., The, Seattle, Wash.	360
WRAA	Rice Institute, Houston, Tex.	360
KFCM	Richmond Radio Shop, Richmond, Cal.	360
WKN	Riechman-Crosby Co., The, Memphis, Tenn.	360

Call	Station	Wave-Lengths
WHAK	Roberts Hardware Co., Clarksburg, W. Va.	360
WNAL	Rockwell, R. J., Omaha, Neb.	360
KFID	Ross Arbuckle Garage, Iola, Kan.	246
KNJ	Roswell Public Service Co., The, Roswell, N. M.	360
WMAF	Round Hills Radio Corp., Dartmouth, Mass.	360
WTAU	Ruegy Battery & Elect. Co., Tecumseh, Neb.	360
WIAW	Saginaw Radio & Elect. Co., Saginaw, Mich.	360
WCAD	St. Laurence University, Canton, N. Y.	360
WEW	St. Louis University, St. Louis, Mo.	360
KGY	St. Martin's College, Lacey, Wash.	258
KFDD	St. Michael's Cathedral, Boise, Ida.	360
WCAL	St. Olaf College, Northfield, Minn.	360
WPAT	St. Patrick's Cathedral, El Paso, Texas	360
KFCD	Salem Elect. Co., Salem, Ore.	360
WCAO	Sanders & Stayman Co., Baltimore, Md.	360
WQAF	Sandusky Register, Sandusky, O.	240
WWAC	Sanger Bros., Waco, Tex.	360
KMJ	San Joaquin Light & Power Corp., Fresno, Cal.	360
WRAB	Savannah Board of Public Education, Savannah, Ga.	360
KDYM	Savoy Theatre, San Diego, Cal.	252
WIAO	School of Engineering & Milwaukee & Wisconsin News, Milwaukee, Wis.	360
WHX	Schubel, Geo., Ridgewood, N. Y.	360
WQAN	Scranton Times, Scranton, Pa.	360
WFEQ	Scroggin, J. L., Oak, Neb.	360
KDZT	Seattle Radio Assn., Seattle, Wash.	360
WSAP	Seventh Day Adventist Church, New York, N. Y.	360
KFFA	Shelton, R. O., Dr., San Diego, Cal.	242
WEAN	Shepard Co., Providence, R. I.	360
WNAC	Shepard Stores, Boston, Mass.	360
WFAV	Sheridan Elect. Serv. Co., Rushville, Neb.	360
WLAO	Shilling, A. E., Kalamazoo, Mich.	360
WNAY	Ship Owners Radio Service, Baltimore, Md.	360
WDT	Ship Owners Radio Service, Stapleton, N. Y.	360
WNY	Shotten Radio Mfg. Co., The, Albany, N. Y.	360
KDZB	Siefert, Frank E., Bakersfield, Cal.	360
WDAU	Slocum & Kilburn, New Bedford, Mass.	360
KFFO	Smith, E. H., Dr., Hillsboro, Ore.	360
KDYW	Smith-Hughes & Co., Phoenix, Ariz.	360
KNI	Smith, T. W., Eureka, Cal.	360
WNAQ	Sommes Motor Co., Washington, D. C.	242
WGAZ	South Bend Tribune, South Bend, Ind.	360
WFAZ	South Carolina Radio Shop, Charleston, S. C.	360
WCAT	So. Dak. School of Mines, Rapid City, S. D.	240
KFDY	So. Dak. State College of Agri. & M. Artd., Brookings, S. D.	360
WSAB	Southeast Mo. State Teachers College, Cape Girardeau, Mo.	360
KDPT	Southern Electrical Co., San Diego, Cal.	360
WOAI	Southern Equipment Co., San Antonio, Tex.	360
WBT	Southern Radio Corp., Charlotte, N. C.	360
WGAR	Southwest American, Fort Smith, Ark.	360
WQAB	Southwest Mo. State Teachers College, Springfield, Mo.	360
WOAU	Sowder-Bolling Piano Co., Evansville, Ind.	360
WGAD	Spanish-American School of Radio Telegraphy, Ensanada, P. R.	360
WSAA	Sprague Elect. Co., B. S., Marietta, Ohio	360
WFAF	Spratley, Henry C., Poughkeepsie, N. Y.	360
KFAP	Standard Pub. Co., Butte, Mont.	360
WEAB	Standard Radio Equip. Co., Fort Dodge, Iowa	360
KDYX	Star Bulletin Pub. Co., Honolulu, T. H.	360
KFHR	Star Elec. & Radio Co., Seattle, Wash.	270
WKAC	Star Pub. Co., Lincoln, Neb.	275
KFAE	State College of Washington, Pullman, Wash.	360
WRAC	State Normal School, Mayville, N. D.	360
WHAA	State University of Iowa, Iowa City, Iowa	283
WBAX	Stenger, John H., Jr., Wilkes-Barre, Pa.	360
WBAD	Sterling Elec. Co., Minneapolis, Minn.	360
WBBC	Sterling Radio Equip. Co., Sterling, Ill.	229
WCK	Stix-Baer-Fuller, St. Louis, Mo.	360
WFI	Strawbridge & Clothier, Philadelphia, Pa.	395
WBAL	Superior Radio & Tel. Co., Columbus, Ohio	286
WFAC	Superior Radio Co., Superior, Wis.	360
WHB	Sweeney School Co., Kansas City, Mo.	411
WNAX	Syracuse Radio & Tel. Co., Syracuse, N. Y.	286
WDAE	Tampa Daily Times, Tampa, Fla.	360
WBL	T. & H. Radio Co., Anthony, Kan.	261
WRW	Tarrytown Radio Research Lab., Tarrytown, N. Y.	273
WRAD	Taylor Radio Shop, Marion, Kan.	360
KDYL	Telegram Pub. Co., Salt Lake City, Utah	360
WNAS	Texas Radio Corp. & Austin Statesman, Austin, Tex.	360
KFBU	Thomas, Bishop N. S., Laramie, Wyo.	360
WRAR	Thomas, Jacob Carl, David City, Neb.	226
KFBH	Thomas Musical Co., Marshfield, Ore.	360
WHAB	Thompson, Clark W., Galveston, Texas	360
KFIJ	Thorean, Sidney I., Platte, S. D.	236
KHJ	Times Mirror Co., Los Angeles, Cal.	395
WFAM	Times Pub. Co., St. Cloud, Minn.	360
WMAL	Trenton Hdwe. Co., Trenton, N. J.	256
KDYS	Tribune, The, Inc., Great Falls, Mont.	360
KLN	Tribune Pub. Co., Oakland, Cal.	360
WDAH	Trinity Methodist Church, So. El Paso, Texas	360
WMAG	Tucker Elec. Co., Liberal, Kan.	360
WAAC	Tuland University of La., New Orleans, La.	360
WLAL	Tulsa Radio Co., Tulsa, Okla.	360
WKAW	Turner Cycle Co., Beloit, Wis.	242
WOAF	Tyler Commercial College, Tyler, Texas	360
WRL	Union College, Schenectady, N. Y.	360
WJAX	Union Trust Co., Cleveland, Ohio	390
WKAN	United Battery Service Co., Montgomery, Ala.	226
WAAP	United Elec. Co., Wichita, Kan.	360
WPO	United Equip. Co., Memphis, Tenn.	360
KFDH	University of Ariz., Tucson, Ariz.	360
KOI	University of Cal., Berkeley, Cal.	360
WHAG	University of Cincinnati, Cincinnati, Ohio	222
KFAJ	University of Colo., Boulder, Colo.	360
WRN	University of Illinois, Urbana, Ill.	360
WLB	University of Minn., Minneapolis, Minn.	360
WAAN	University of Mo., Columbia, Mo.	360
WFAV	University of Neb., Lincoln, Neb.	360
WNAD	University of Okla., Norman, Okla.	360
WHAM	University of Rochester, Rochester, N. Y.	360
WFAJ	University of S. D., Vermillion, S. D.	360
WOM	University of Texas, Austin, Tex.	360
WCAX	University of Vermont, Burlington, Vt.	360
WHA	University of Wis., Madison, Wis.	360
WSAI	U. S. Playing Card Co., Cincinnati, Ohio	309
WMAP	Utility Battery Service, Inc., Easton, Pa.	246
KFHD	Utz Elec. Co., St. Joseph, Mo.	226
WOAB	Valley Radio, Grand Forks, N. D.	360
WOAN	Vaughan, James D., Lawrenceburg, Tenn.	360
WLAK	Vermont Farms Mach. Co., Bellows Falls, Vt.	360
WSAV	Vick, Clifford W., Houston, Tex.	360
WCAM	Villanova College, Villanova, Pa.	360
KFAY	Virgin's Radio, Medford, Ore.	360
WLAJ	Waco Elec. Supply Co., Waco, Tex.	360
WMAW	Wahpeton Elect. Co., Wahpeton, N. D.	360
WDAS	Waite, Samuel A., Worcester, Mass.	360
WWZ	Wanamaker, John, New York, N. Y.	360
WOO	Wanamaker, John, Phila., Pa.	509
WBAR	Ward, R. A., Beloit, Kan.	360
KLS	Warner Brothers, Oakland, Cal.	360
KHQ	Wasmer, Louis, Seattle, Wash.	360
WMAR	Waterloo Electrical Sup. Co., Waterloo, Iowa	360
KFBD	Welch, Clarence V., Hanford, Cal.	360
KFJD	Weld County Ptg. & Pub. Co., Greeley, Colo.	236
KZV	Wenatchee Battery & Motor Co., Wenatchee, Wash.	360
WQAQ	West Texas Radio Co., Abilene, Texas	360
WHD	West Virginia University, Morgantown, W. Va.	360
WBAY	Western Elec. Co., New York, N. Y.	405
KFAF	Western Radio Corp., Denver, Colo.	360
WOQ	Western Radio Co., Kansas City, Mo.	360
KFCY	Western Union College, LeMars, Iowa	360
KYW	Westinghouse Elect. & Mfg. Co., Chicago, Ill.	345
KDPM	Westinghouse Elect. & Mfg. Co., Cleveland, Ohio	270
KDKA	Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.	326
WBZ	Westinghouse Elect. & Mfg. Co., Springfield, Mass.	337
WQAD	Whiteall Elect. Co., Waterbury, Conn.	242
WJH	White & Boyer Co., Washington, D. C.	273
WJAK	White Radio Lab., Stockdale, O.	360
WEAH	Wichita Board of Trade & Landers Radio Co., Wichita, Kan.	360
WPAD	Wieboldt & Co., W. A., Chicago, Ill.	360
WHAV	Wilmington Elect. Specialty Co., Wilmington, Del.	360
KFEL	Winner Radio Corp., Denver, Colo.	360
WRAP	Winter Park Elect. Const. Co., Winter Park, Fla.	360
WRAN	Wireless Phone Corp., Paterson, N. J.	244
WNO	Wireless Telephone Co., Jersey City, N. J.	360
WPAH	Wisconsin Dept. of Markets, Waupaca, Wis.	360
WNAP	Wittenberg College, Springfield, O.	360
WFAB	Woese, Carl C., Syracuse, N. Y.	234
WOAX	Wolff, Franklyn J., Trenton, N. J.	240
WOAW	Woodmen of the World, Omaha, Neb.	360
WOAL	Woods, W. E., Webster Grove, Mo.	360
WIAY	Woodward & Lothrop, Washington, D. C.	360
WLAH	Woodworth, Samuel, Syracuse, N. Y.	234
WWAX	Wormser Brothers, Laredo, Tex.	360
WBAP	Wortham-Carter Pub. Co., Fort Worth, Tex.	476
WWAD	Wright & Wright, Inc., Philadelphia, Pa.	360
WKAF	W. S. Radio Supply Co., Wichita Falls, Texas	360
WAAY	Yahrling-Rayner Piano Co., Youngstown, Ohio	360
KFIQ	Yakim Valley Radio Broadcasting Assn., Yakim, Wash.	234
KOA	Y. M. C. A., Denver, Colo.	360
WABE	Y. M. C. A., Washington, D. C.	283
WKC	Zamoiski Co., Jos. M., Baltimore, Md.	360
WIAE	Zimmerman, Mrs. Robt. E., Vinton, Iowa	360

Calls Heard

5LG, A. K. TATUM, ALAMOGORDO, N. M. (MOSTLY ONE TUBE)

C.W.: 2KF, 3ZO, 5AAE, 5AEC, 5AER, 5AHC (5AHD), 5AHR, 5AGN, 5AKV, (5AKZ), 5AIF, 5AIU, 5AJB, 5AKI, 5AKN, 5AKY, 5AMO, 5AMW, 5BM, 5CY, 5EK, 5EN, 5ET, 5FT, 5GA, 5GG, 5GJ, 5GN, 5GR, 5HZ, 5JT, 5JZ, 5KC, 5KE, 5KK, 5KP, 5KW, 5MO, (5MN), 5MT, 5NK, 5NN, 5OK, 5OI, 5OV, 5PD, 5PX, 5QI, 5QM, 5RN, 5SP, 5TP, 5UI, 5VM, (5VO), 5VY, 5XAD, 5XAI, 5XB, 5XD, 5XV, 5YK, 5ZA, 5ZAD, 5ZAK, 5ZAT, 5ZAV, 5ZD, 5ZH, 6AAK, 6AHU, 6ALK, 6ALW, 6ATY, 6AWX, 6BA, 6BAH, 6BAW, 6BEO, 6BGY, 6BLC, 6BJX, 6BJY, 6BOD, 6BOC, 6BOD, (6BUN), 6BUO, 6BUR, 6BV, 6BVF, 6BVG, 6CBU, 6CGU, 6FC, (6CBD), (6BU), 6HV, 6KM, 6MH, 6TW, 6VG, 6XAI, 6ZAO, 6ZH, 6ZZ, 7ABB, 7AFW, 7HS, 7IO, 7PF, 7LN, 7ZF, 7ZG, 7ZN, 7ZU, 7ZV, 8CF, 8CNO, 8CUR, 9AAH, 9AAU, 9ABV, 9ABZ, 9AEC, 9AED, 9AEY, 9AHZ, 9AHV, 9ALG, 9AOG, 9APF, 9ARZ, 9ASO, 9AUL, (9AUW), 9AYL, 9AYU, 9BIB, 9BJJ, 9BJK, 9BKC, 9BKI, 9BM, 9BOD, 9BRI, 9BTO, 9BUN, 9BXM, 9BXO, 9BXT, 9BXY, 9BZF, 9BZH, 9BZI, 9BZZ, 9CAA, 9CAC, 9CAO, 9CBA, 9CCV, (9CCZ), 9CFI, 9CFY, 9CGA, 9CIP, 9CIY, 9CKM, 9CLQ, 9CMK, 9CUC, 9CVC, 9CVO, 9CWJ, 9CAN, (9DEZ), 9DGA, 9DGV, 9DHW, 9DIB, 9DN, 9CRW, 9DSM, (9DTE), 9DVI, 9DWN, 9EAE, 9EAK, 9ECZ, 9EEA, 9EHV, 9EKY, 9FV, 9HK, 9IF, 9PF, 9QF, 9SS, 9UH, 9UU, 9VE, 9XAQ, 9YB, 9ZT.

SPK: 5TP, 5UD, 5XAJ, 6APH, 6APL, 9ASO, 9BOF.

PHONE: 5AHD, 5AKI, 5AKZ, 5LT, 5XAJ, 5XD, 6CBI.

JOHN H. ECKARDT, FRESNO, CALIF. (ONE TUBE)

6AW, 6AAK, 6AFA, 6AHV, 6AOP, 6AOU, 6AOO, 6AUU, 6BAH, 6BEG, 6BGC, 6BIH, 6BON, 6BOP, 6BUO, 6BWE, 6BXA, 6CAN, 6CAY, 6CEU, 6CKC, 6CKL, 6CFS, 6CGD, 7ABS, 7ADR, 7AFW, 7CH, 7IE, 7NA, 7OH, 7OT, 7ZT, 7ZU, 9CFY, 9QL, 9CZG.

8DFK, WAVERLY, N. Y.

1AB, 1AGM, 1AR, 1ARM, 1ASK, 1BAS, 1BFT, 1BME, 1BXL, 1BZI, 1CDO, 1CIH, 1DI, 1HJ, 1JH, 1JV, 1MC, 1NY, 1XA, 1XX, 2AA, 2AHP, 2AIP, 2ANM, 2BG, 2BRG, 2CI, 2CM, 2CPA, 2CT, 2CXC, 2PZ, 2TJ, 3ABW, 3AH, 3AKO, 3AP, 3AS, 3ASO, 3ATS, 3AWU, 3BH, 3BI, 3BMN, 3BO, 3BSS, 3BVA, 3BWT, 3CB, 3CEL, 3CEO, 3CKN, 3CO, 3GL, 3HA, 3IJ, 3JJ, 3ME, 3OE, 3RF, 3SI, 3TJ, 3TR, 4EW, 4FT, 4KC, 4MR, 5EC, 5NA, too many 8's, 9AA, 9APS, 9ARI, 9ATO, 9BCF, 9BCL, 9BDS, 9BIJ, 9BO, 9BOD, 9BY, 9BZI, 9CBA, 9CDB, 9CDO, 9CGF, 9CHK, 9CHO, 9CIM, 9CIR, 9CKM, 9CNV, 9CR, 9CTR, 9CVO, 9DCR, 9DHR, 9DI, 9DOV, 9DUO, 9DZX 9ECE, 9EI, 9EP, 9ER, 9OR, 9UL, 9UO, 9VZ.

JOHN E. HORTON, POINT, TEXAS (ONE TUBE)

All C. W.—5AEJ, 5ADG, 5AFU, 5DHB, 5EK, 5XAJ, 5XZ, 5ZA, 5ZM, KDKA, KFAD, KFAF, KFEL, KFFO, KHJ, KLZ, KOB, KSD, KUO, KYW, DM7, WAAP, WAAW, WAAZ, WBAP, WBL, WBT, WCAG, WCAL, WCAR, WCAS, WCAY, WCAZ, WCK, WCM, WCX, WDAF, WDAJ, WDAO, WDAP, WEAH, WEAY, WEV, WEY, WFAA, WFAJ, WGF, WGM, WGV,

(*Continued on page* 188)

MAGNAVOX

Radio in Summer

THE man who purchases a Magnavox for its clearness of reproduction, finds additional advantages in its use which contribute greatly to his enjoyment of Radio.

For instance, due to its extreme sensitivity, the Magnavox can clearly reproduce signals which otherwise would be indistinguishable.

This means a great increase in distance range—more stations brought within the Magnavox owner's reach.

Magnavox Reproducers and Power Amplifiers can be used with any receiving set of good quality. Without Magnavox, no receiving set is complete.

Magnavox R2 Reproducer and 2 stage Power Amplifier (as illustrated) **$115.00**

R2 Magnavox Reproducer with 18-inch curvex horn: the utmost in amplifying power; requires only .6 of an ampere for the field **$60.00**

R3 Magnavox Reproducer with 14-inch curvex horn: ideal for homes, offices, etc. . . . **$35.00**

Model C Magnavox Power Amplifier insures getting the largest possible power input for your Magnavox Reproducer.

AC-2-C, 2-stage, $55.00
AC-3-C, 3-stage, $75.00

A clearer Radio voice, sounding above the tumult of vacation time

WHEN days are spent in summer's outdoor playgrounds, Magnavox needs only an instant's notice to supply dance music, sporting news or entertainment for all.

Open places test impartially the real quality of Radio reproduction—with Magnavox equipment your receiving set will give superbly adequate performances, indoors or out, the year 'round.

Magnavox products can be had of good dealers everywhere. Send for copy of unusual booklet.

The Magnavox Co., Oakland, California
New York: 370 Seventh Avenue

MAGNAVOX Radio

The Reproducer Supreme

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What do you want to know about fibre?

RADIO builders everywhere are using vulcanized fibre in their products. They know that it is a perfect non-conductor, that it is non-corrosive, that it is more easily worked than rubber. They know that it is much less costly than any of the materials for which it is substituted.

But often a manufacturer will refrain from using vulcanized fibre because he is not sure of all of its qualities. He knows exactly what rubber, or metal or wood will do—how he can work it and what it will cost him.

Can't we clear up these questions—make plain just what fibre is, just what it will do and just how you can use it to advantage in your product?

The National Vulcanized Fibre Company has three-fold facilities for the production and delivery of Vul-Cot Fibre—fibre with a nation-wide reputation. Each step of its manufacture is under such close supervision that we can guarantee it to be pure—free from foreign material.

The experience of years in the manufacture of Vul-Cot Fibre and Vul-Cot fibre parts for many of the nation's greatest manufacturers is at your disposal. Write today.

National Vulcanized Fibre Company

Wilmington, Del.

Book Review

101 RECEIVING CIRCUITS (The Green Book). By M. B. Sleeper. 6"x9", 47 pages. Published by M. B. Sleeper, Inc., Technical Publisher, 88 Park Place, New York City.

For a person who likes to experiment with different receiving circuits, or for one who is undecided as to what type of circuit he wishes to use, this little book becomes invaluable. Diagrams, covering various types of regenerative, super-regenerative, super-heterodyne, reflex, radio frequency, Reinartz, Flewelling and neutrodyne sets, are included, as well as circuits of simple crystal receivers, etc. A list of radio symbols is contained in the front of the book for the convenience of those who are unfamiliar with conventional diagrams. Many helpful hints are included in the text, which should assist the reader in perfecting his own receiving set.

SIX SUCCESSFUL RADIO SETS (The Red Book). By M. B. Sleeper. 6"x9", 47 pages. Published by M. B. Sleeper, Inc., Technical Publisher, 88 Park Place, New York City.

Six Successful Radio Sets is a little book describing in detail the construction and operation of five different types of receiving sets, and a two-stage audio frequency amplifier. These sets have been especially selected as the most practical and efficient types of those of the present time. The design, data and instructions for building are complete. The panel layout dimensions and the means of wiring are given in connection with the description of each set. Nothing is left to the imagination.

AMATEUR RADIO CALL-BOOK. 6¾" x9¾", 159 pages. Published by Radio Directory and Publishing Company, 45 Vesey Street, New York City.

The Amateur Radio Call-Book fills the want for a complete radio directory of existing radio stations. The list includes the call-letters and locations of amateurs, special amateurs, technical and training stations, radiophone broadcasting stations of the United States and Canada, commercial land stations and Army and Navy land stations of the United States; also the principal high-powered trans-oceanic stations of the world, with their respective work wave-lengths, type of transmitters and press schedules.

A detailed description of the construction and operation of the well known Reinartz receiver, in conjunction with a one-stage audio-frequency amplifier, is included in the front pages of this book.

The most attractive feature of this directory is the two-color map of the United States and Canada, 3x3 feet, showing radio district boundaries, standard time lines and geographical locations of broadcasting stations. An alphabetical list of broadcasting stations is contained on the map, as well as in the book. The map is of such size that there is ample room for the insertion of call letters of new broadcasting stations.

LISTEN-IN RADIO RECORD. Arranged by Roy C. Baker. 5½"x8½". Flexible fabrikoid binding. Gold stamping. 160 pages. Printed on bond paper to take ink. Published by Lothrop, Lee & Shepard Company, 275 Congress Street, Boston, 9, Mass.

The advance in the quality and quantity of radio broadcasting during the past year and the variety of programs offered have led to a demand by the public for a means of keeping permanent records of such broadcasts. The Listen-In has been compiled for this purpose, and will enable radio enthusiasts to record the programs of various stations heard. This little book contains as well a complete list of broadcasting stations and a double-page map of the United States, showing locations of all the principal stations. Space is provided for an additional recording of new broadcasting stations, this space being so arranged that the corresponding dial adjustments on the receiving set may be noted after the stations' call-letters.

The introductory article—"How to Receive Radio Broadcasts," by Lloyd C. Greene, Radio Editor of the Boston *Globe*—covers the construction and operation of a simple and efficient type of regenerative receiving set. This is followed by a page of radio tips, which prove invaluable as reference.

GETTING ACQUAINTED WITH RADIO RECEIVERS. By Paul Godley. 6"x9", 32 pages. Published by Adams-Morgan Company, Upper Montclair, N. J.

Mr. Godley has well succeeded in explaining the operation of radio receivers, in non-technical language, so that the novice should find it easily understandable.

Although the book is concerned mostly with the operation of the Paragon RA-10 and RD-5 receivers, the information given in the book is written in such a manner that it could be applied to any type of receiving set.

Of general interest are the chapters covering the vacuum tube, tuning and resonance, regeneration, antennae systems, body-capacity effects, and the faults of receiving sets and their remedies.

A glossary is included in the rear of the book, giving the simplified definitions of the most widely used radio terms.

RADIO TELEPHONY FOR AMATEURS. By Stuart Ballantine. 5½"x 8½", cloth bound, 296 pages, fully illustrated. Published by David McKay Company, Philadelphia.

Starting with the fundamental principles of electricity, upon which radio telephony is based, Mr. Ballantine well prepares the reader for the following chapters, covering its more complicated actions. The book is written in such a comprehensible form that the word "wading" cannot be applied to the reading of its contents. The entire subject of radio telephony is boiled down to the point of conciseness, yet nothing of importance is left out.

The action of the vacuum tube is explained in the forepart of the book, followed by its applications to numerous types of circuits. Much helpful data is given on antennae systems, this including as well the construction of aerials and grounds for both transmitting and receiving. Of particular interest is the information covering the construction and operation of radiophone transmitters and receivers.

RADIO HOOK-UPS. Published by the Rauland Manufacturing Co., 200 No. Jefferson St., Chicago, Ill.

A small booklet, containing 22 hook-ups of receiving sets in conjunction with radio and audio-frequency amplifiers. Much helpful data on radio and audio-frequency transformers, especially the "All American" manufacture, is included in the forepart of the booklet, as well as a page of symbols. This pamphlet will be sent to anyone upon the receipt of two cents to cover the postage.

DER FUNKTELEGRAPHISCHE WETTERUND ZEITZEICHENDIENST. By H. Thurn. Published by M. Krayn, Verlagsbuchhandlung, Berlin W. 10.

In its 82 pages this little work gives an excellent presentation of two phases of wireless work.

The first phase treated of is the prediction of weather changes by radio. The practice, as far as developed before the World War, is given and the subsequent operations in recent days, in Germany and abroad, are treated of. A list of stations of the German radio weather service is supplied, with their code letters. The stations are 21 in number and a further list gives the same information of the International European Stations—37 in number.

It may not seem ungenerous to express the hope that the weather predictions abroad run higher in percentage of accuracy than they do here.

The second subject treated is time service and, within the limits of some 40 pages, the matter is quite fully described, with a number of illustrations and diagrams. Time service is not only a very definite thing, but is of the greatest importance to navigation at sea. An error in time gives a ship the wrong longitude and, as the ocean is crossed eastward and westward, this error is the worst and most dangerous.

We commend the book to our readers.

What Radio Can Do for the Country

(*Continued from page* 135)

music and education. Radio broadcasts the world's best treasures.

Go to the four corners of the globe, and you will not be isolated if you have your radio set with you. Just like Alladin's lamp, the marvelous, bounteous gift of radio broadcasting comes to you through unknown space, with gifts that are beyond your wildest dreams. It so happened that in this little country town there lived an estimable citizen known to all as "Uncle George." He had spent most of his life in the steel industry, had retired from active work and had settled down to a quiet, sedate existence in that very quiet country com-

(*Continued on page* 181)

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BUILD YOUR SET WITH BARAWIK STANDARD RADIO GOODS

PLATE CIRCUIT "B" BATTERIES

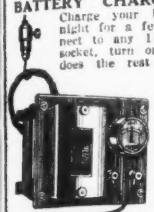
You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

G180 Signal Corps type, small size, 15 cells, 22½ volts. Each....95c

G184 Variable Large Navy size, 6¼x1x3 inches 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.....$1.80

G188 Combination Tapped 45 volts 30 cell, 12x4x2 battery. Tapped to give 45, 22½, 21, 19½, 18 and 16½ volts. Handles both detector and amplifier tubes. Each.....$3.35

HOMECHARGER BATTERY CHARGING RECTIFIER

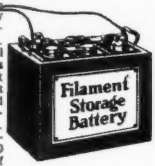


Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices are Transportation Paid.

G201 For 6 volt battery $13.95
G203 For 12 volt battery 13.95

STORAGE "A" BATTERY



A very high grade battery made especially for radio service. Guaranteed for three years. Properly cared for will give many more years of service for filament lighting. Made of best new materials. Full capacity. The best battery buy on the market. Try one of these batteries on your set for 10 days. If at the end of that time you are not fully satisfied with the battery return it and we will refund the purchase price.

G194 6 volt, 40 ampere size. Each....$10.00
G196 6 volt, 80 ampere size. Each.... 12.50

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

G105 Detector, UV200 C300 Ea.$4.30
G112 Amplifier, UV201A C301A 5.95
G118 5 Watt Transmitter 7.70
G107 WD11 1½ v. Fil. Each.....$5.95
G101 WD12. Each 5.95
G102 UV199. Each 5.95
G103 UV199. Socket 59c
G104 UV199 Adapter 49c
G108 WD11 Socket. Each..... 49c
G109 WD11 Adapter. Each..... 48c

FILAMENT CONTROL RHEOSTATS

Best grade. High heat resisting base. Diam. 2⅜ in. cap 1½ amp. Resist. 6 ohms. 1¼ in. knob with pointer. 75c value.

G132 Each 45c

G131—25 Ohm Rheostat for 301A, 201A tubes 69c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 110 ohms.

G133 Each 89c

VERNIER RHEOSTAT

Gives exceedingly fine control of "A" battery current. A necessity for best receiving results.

G135 Each 69c

VACUUM TUBE SOCKETS.

Our Special Socket. A wonderful value. Moulded entirely of brown bakelite. Four binding post connections. Right angled contact springs.

G140 Each 39c

High Grade combination type for panel or table mounting. Metal tube. High insulation base. One of the best sockets made.

G146 Each 45c

TWO AND THREE GANG SOCKETS

These sockets make it easy to build detector and amplifier units and make a neat, compact workmanlike job. Grade materials. Perfectly made of high Quickly mounted on panel or base.

G147 Two-gang socket $1.05
G148 Three-gang socket 1.45

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and knob. Brass parts polished nickel finish. An unequaled value.

G732 Each 50c

DETECTOR CRYSTALS CAREFULLY TESTED

G736 Galena, Arlington tested, per piece. 19c
G738 Silicon, Arlington tested, per piece. 19c
G735 Tested, Galena, per piece..... 9c
G737 Tested, Silicon, per piece..... 9c

WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

FAST SERVICE—TRY US AND BE CONVINCED

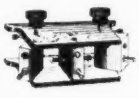
THIS GUARANTEE PROTECTS YOU—Examine the goods we ship you. They must suit you in every respect.. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

"HONEYCOMB" COILS

Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art No.	Net Mntd.	Art No.	Price Mntd.
25	120- 250	G301	$0.39	G320	$0.89
35	175- 450	G302	.42	G322	.96
50	240- 720	G303	.49	G323	1.04
75	390- 910	G304	.54	G324	1.08
100	500- 1450	G305	.58	G325	1.13
150	600- 2000	G306	.63	G326	1.17
200	900- 2500	G307	.72	G327	1.26
250	1200- 3500	G308	.78	G328	1.35
300	1500- 4500	G309	.82	G329	1.36
400	2000- 5000	G310	.97	G330	1.57
500	2800- 6100	G311	1.12	G331	1.63
600	4000-10000	G312	1.27	G332	1.78
750	5000-12000	G313	1.43	G333	1.93
1000	7900-15000	G314	1.70	G334	2.28
1250	9750-19500	G315	1.92	G335	2.49
1500	14500-26500	G316	2.18	G336	2.65

COIL MOUNTINGS



G340 Three-coil mounting $3.95
G341 Two-coil mounting $2.95

High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

RADIO JACKS AND PLUGS

Finest grade jacks. Improved design. Best materials. Phosphor bronze springs. Silver contact points. Nickel finish. Mount on panels ⅛ to ⅜ in. thick.

Jacks Only
- G390 Open circuit. Each.....43c
- G391 Closed circuit. Each.....49c
- G392 Two circuit. Each.....60c
- G393 Single circuit filament cont. 69c
- G394 Two circuit filament cont. 85c

G395 Plug. Large space with set screws for attaching cord. Each..... 49c

BINDING POSTS

Brass, polished nickel finish. Washer and 6-32 in. screw extending ⅝ in.

G370 Large size—barrel and knob ⅝ in. long, dozen .85c
G372 Smaller size—barrel and knob 9-16 in. long, dozen.....70c
G374 Large size with composition knob, dozen.....50c
G376 Large size with hole for phone tip or wire, dozen.....80c
G378 Small size with hole for phone tip or wire, dozen.....35c

SWITCH CONTACT POINTS

Brass polished nickel finish. All have ⅝ in. long size 6-32 screws and two nuts. All prices the same.

Hundred $1.05
Dozen 18c

Order by Article Number.

G360 Head, ¼ in.; Diam. ⅝ in. High
G362 Head, 3-16 in.; Diam. ⅝ in. High
G363 Head, 3-16 in.; Diam. 1-16 in. High

SWITCH LEVERS

Moulded composition knob. Exposed metal parts polished nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

G382 1½ in. Radius
G381 1¼ in. Radius } 19c Ea.
G380 1 in. Radius

SWITCH LEVER STOP

Brass, polished nickel finish.

G386—Dozen 18c. Hundred $1.05

ONE-PIECE DIAL AND KNOB

Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

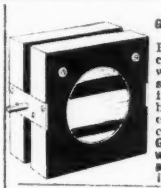
G900 2 in. Diam. for 3-16 in. shaft. Ea....19c
G901 2 in. Diam. for ¼ in. shaft. Ea.....19c
G904 3 in. Diam. for 3-16 in. shaft. Ea....25c
G905 3 in. Diam. for ¼ in. shaft. Ea.....25c
G906 3½ in. Diam. for 3-16 in. shaft. Ea. 35c
G907 3½ in. Diam. for ¼ in. shaft. Ea..35c

OUTDOOR LIGHTNING ARRESTER

G980 Price $1.58

Protect your instruments with this lightning arrester. You cannot afford not to. Weatherproof porcelain case. Air gap type. Permanent. Durable. The most practical quality arrester obtainable. Underwriters approved.

VARIOMETER

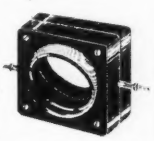


G410—Completely assembled, price $2.69

Perfect in design and construction. Accurate wood forms of genuine solid mahogany. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency. A real bargain.

G411—Not assembled nor wound but all parts complete except wire, including winding form. $1.48

MOULDED VARIOMETER



Polished black moulded rotor and stator forms. Maximum inductance with greatest efficiency and minimum distributed capacity. A high grade durable instrument that will make up into a set you will be proud of and will get the best results. Wave length 180 to 600 meters. 4¾ in. square, 1⅞ in. thick.

G412 Price including mounting brackets $3.48

IMPROVED 180° VARIO-COUPLER

G418 Price $2.89

Our price shows you a big saving. An instrument of highest quality. The most efficient type of coupler, insures sharper tuning and louder signals. Primary and secondary wound on genuine bakelite tubes. Secondary connections through soldered flexible cables eliminates contact noises. Primary has 7 taps. Can be panel or table mounted. Range 180 to 650 meters.

MAGNET WIRE

Insulated copper wire. Best quality even drawn wire, one piece to a spool. Prices quoted are for 8 oz. spools.

Double Cotton Covered		Enameled Insulation		Green Silk Covered	
Number G990		Number G992		Number G991	
Gauge	Price	Gauge	Price	Gauge	Price
18	50c	20	.45c	20	$0.78
20	60c	22	.55c	22	.90
22	75c	24	.61c	24	1.05
24	85c	26	.65c	26	1.18
26	.95c	30	.70c	30	1.70
28	$1.15	32	.79c	32	2.05
30	1.65	36	.98c	36	2.75

STRANDED ANTENNA WIRE

Cabled of fine copper strands. Very flexible. High tensile strength. Best for aerials.

G248—100 ft. coil 72c G249—500 ft. coil $3.20

SOLID BARE COPPER WIRE

Solid bare copper wire for aerials, leads or wiring instruments.

Solid Bare Copper Wire, size 14

G240—100 ft. coil 49c G242—500 ft. coil $2.35

Solid Bare Copper Wire, size 12

G244—100 ft. coil 67c G245—500 ft. coil $3.05

ANTENNA INSULATORS

G260 Size 1x3½. Two for 17c
G267 Size 2⅜x3½. Two for 55c
G264 Size 1½x4. Two for 69c
G266 Size 1½x10½. Two for $1.28

G260 G262 G264-6

PHONE AND GRID CONDENSERS

A compact style of condenser that is very satisfactory. Conducting sheets and dielectric are wound on fiber strip with eyelets for mounting and connections. Each 12c

G170 Phone Condenser .001 Mfd.
G172 Phone Bridging Condenser .0005 Mfd.
G174 Grid Condenser .00025 Mfd.
G175 Condenser .006. Each.....25c
G176 Grid Condenser .00025 with pencil mark leak. Each.....24c

TUBULAR GRID LEAKS AND CONDENSERS—MOUNTED STYLE

Very convenient. Permits quick change of leaks or condensers of varying capacities.

Grid Leaks Each	Price	Resistance	Price
G850	.5 Meg.	G855	.2 Meg.
G851	1 Meg.	G857	.3 Meg.
G853	1.5 Meg.	G859	.5 Meg.

GRID AND PLATE CONDENSERS

Price, each 55c

G832 .0001 Mfd. For special circuits
G834 .00025 Mfd. For U.V.201 and Cun. 301
G836 .0005 Mfd. For U.V.200 and Cun. 300

MOUNTINGS

Bakelite base. Spring clip contact.

G840 Single mounting. Each.....32c
G842 Double mounting. Each.....57c
G844 Triple mounting. Each.....76c

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling due to proper impedence ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

G234 10 to 1 Mounted. Each.....$3.48
G235 10 to 1 Unmounted. Each..... 2.95
G236 3 to 1 Mounted. Each..... 3.40
G237 3 to 1 Unmounted. Each..... 2.85

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

G812 43 plate .001 Mfd. $1.73
G813 21 plate .0005 Mfd. 1.43
G814 11 plate .00025 Mfd. 1.32
G815 3 plate Vernier ..... .96

These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Fine polished end plates of heavy bakelite. Shafts ¼ inch diameter. Sturdy, heavy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

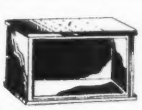
G824 23 plate .0005 Mfd. with dial and knobs. Price....$2.89
G826 43 plate .001 Mfd. with dial and knobs. Price....$3.45

The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial mounted with a three plate vernier condenser, which is controlled by separate knob mounted above knob on dial. This arrangement permits of very fine tuning. Compact convenient mounting on panel. High grade design and construction. Finely finished.

STANDARD BRAND HEADSETS

G754 Baldwin Type C with universal tap plug $11.75
G755 Baldwin Type C unit with cord $5.50
G756 Red-Head, 3000 ohm 5.75
G768 Brandes, 2000 ohm 6.90
G770—2000 ohm Barawik 3.75
G751 Murdock 56, 2000 ohm 4.20
G752 Murdock 56, 3000 ohm 4.95
G764 Frost, 2000 ohm 4.20
G766 Frost, 3000 ohm 4.85
G758 Western Electric, 2200 ohm 9.50

CABINETS



Fine looking cabinets solidly built. Elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5½"	6½"	7"	G420	$2.48
6x10½"	5½"	10 "	7"	G422	2.75
6x14"	5½"	13½"	7"	G424	3.30
7x14"	6½"	13½"	7"	G423	3.60
7x18"	6½"	17½"	7"	G425	3.90
7x21"	6½"	20½"	7"	G425	4.20
9x14"	8½"	13½"	10"	G428	3.70
12x14"	11½"	13½"	10"	G430	4.40
12x21"	11½"	20½"	10"	G432	5.25

RADIO "BAKELITE" PANELS

Notice our very low prices on this fine quality material. We supply genuine Bakelite, Condensite Celeron or Formica, all of which are materials with practically identical mechanical, chemical and electrical properties. Machines well without chipping. Won't warp. Waterproof. Highest mechanical and dielectric strength. Attractive natural polished black finish which can be sanded and oiled for extra fine work.

Panel Size Inches	¼" thick Art. No.	Price	⅜-1/6" thick Art. No.	Price	½" thick Art. No.	Price
6x7	G450	$0.50	G460	$0.75	G470	$0.98
6x10½	G451	.75	G461	1.11	G470	1.47
6x14	G452	1.05	G462	1.55	G472	2.05
7x14	G458	1.20	G468	1.80	G478	2.40
7x18	G453	1.55	G463	2.30	G473	3.10
7x21	G457	1.78	G467	2.65	G477	3.60
9x14	G454	1.60	G464	2.30	G474	3.10
12x14	G455	2.10	G465	3.10	G475	4.15
12x21	G456	3.15	G466	4.65	G476	6.20

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed. G160 Each..... 18c

GRID CONDENSER

G162 Mounting holes spaced to fit lugs of above leak. Cap. .00025 MF. 14c
G163 Same as 162 but higher grade. Enclosed in metal case. 39c

To "Make Your Own"

ASK FOR

"Consolidated" Patterns OR E.I.Company 25c. Books

These books and patterns were written and prepared by well known experts. They cover every desired phase of radio. Technically correct but so simple that even a child can understand them.

See Full Page Ad on Pages 200 and 232

The following Dealers carry a complete assortment of Consolidated Patterns at 50c and E. I. Books at 25c.

Albany, N. Y., Albany Radio Corp.
Albany, N. Y., Havens Electric Co.
Albany, N. Y., Ignition Service Supply Co.
Albany, N. Y., Schroeder Electric Co.
Albany, N. Y., Sternberg Bk. & Mus. House
Allentown, Pa., Hess Brothers
Allentown, Pa., F. & W. Grand Stores
Altoona, Pa., Altoona Elec. Sup. Co.
Anthony, Kans., Le Roy Hughbanks Rad.Co.
Astoria, L. I., Astoria Radio Shop
Atchison, Kans. Low & Blythe Company
Atlanta, Ga., Capital Electric Co.
Atlantic City, N. J., Paramount Radio Sup.
Attleboro, Mass., Sweet Accessory Shop
Auburn, Me., G. L. Foss
Baltimore, Md., Jos. A. Becker
Baltimore, Md., Jos. M. Zamoiski
Baltimore, Md., Wilbur Electric Co.
Baltimore, Md., Bacharach Rasin Co.
Baltimore, Md., F. & W. Grand Stores
Baltimore, Md., W. W. Heutzechel
Batavia, N. Y., H. F. Smith
Bethlehem, Pa., Lehigh Radio Company
Billings, Mont., Torgerson Brothers
Birmingham, Ala., Interstate Electric Co.
Bluefield, W. Va., Burgess Electric Co.
Boston, Mass., Atlantic Radio Company
Boston, Mass., Cutter & Wood Supply Co.
Boston, Mass., Seth Fuller Co.
Boston, Mass., International Radio Corp.
Boston, Mass., Lewis Electric Supply
Boston, Mass., F. D. Pitts Co.
Boston, Mass., Williams Book Stores
Boston, Mass., J. R. Hunter & Co.
Boston, Mass., James H. Jones
Bridgeport, Conn., W. T. Grant
Brooklyn, N. Y., Brooklyn Radio Serv. Co.
Brooklyn, N. Y., O. Olsen
Brooklyn, N. Y., Tolmer Electric Co.
Brooklyn, N. Y., Anderson Electric Co.
Brooklyn, N. Y., Brooklyn Radio Center
Brooklyn, N. Y., Bobs Radio Service
Brooklyn, N. Y., Halperin Elec. Sup. Co.
Brooklyn, N. Y., Brooklyn Elec. Lamp and Nov. Co.
Brooklyn, N. Y., F. & W. Grand Stores
Brooklyn, N. Y., Globe Radio & Bat. Shop
Brooklyn, N. Y., Haag & Vince Company
Brooklyn, N. Y., S. S. Kresge
Brooklyn, N. Y., G. Kleinteich
Brooklyn, N. Y., C. G. Rosewall
Brooklyn, N. Y., J. Streiff
Brooklyn, N. Y., Denmarks
Buffalo, N. Y., McCarthy Bros. & Ford
Buffalo, N. Y., Robertson Cataract Elec.Co.
Burlington, N. J., Burton Elec. & Nov. Co.
Butte, Mont., Montana Electric Co.
Cambridge, Mass., Clapp-Eastham Co.
Camden, N. J., Nelsner Brothers
Camden, Ill., Frank White & Brother
Carrollton, Mo., Carrollton Radio Shop
Centerville, Ia., H. E. Luther
Champaign, Ill., H. C. Swannell & Son
Charleston, W. Va., John R. Koch
Charleston, S. Car., S. Car. Radio Shop
Charlotte, N. C., Smith Novotoy Elec. Co.
Chester, Pa., Nelsner Brothers
Chicago, Ill., Harry Alter & Co.
Chicago, Ill., Barawik Company
Chicago, Ill., Beckley-Ralston Co
Chicago, Ill., Chicago Radio App. Co.
Chicago, Ill., Electric Appliance Co.
Chicago, Ill., Inland Electric Co.
Chicago, Ill., Marshall-Field & Co.
Chicago, Ill., A. C. McClurg & Co.
Chicago, Ill., Montgomery Ward & Co.
Chicago, Ill., Newark Electric Co.
Chicago, Ill., Henry Paulson & Co.
Chicago, Ill., Sears-Roebuck & Co.
Chicago, Ill., Chicago Cut Radio Book Co.
Chicago, Ill., Community Book Store
Chicago, Ill., Bernarck Radio Co.
Chicago, Ill., Pollett Book Co.
Chicago, Ill., McArthur Electric Co.
Chicago, Ill., P. O. News Company
Cincinnati, O., Midwest Radio Co.
Cincinnati, O., Milnor Electric Co.
Cincinnati, O., Precision Equipment Co.
Cincinnati, O., Murray Spring Co.
Cincinnati, O., Reuter Electric Co.
Cleveland, O., Elliott Electric Co.
Cleveland, O., Newman-Sterr Co.
Cleveland, O., Radio Electric Shop
Cleveland, O., Radio Eng. & Sales Co.
Cleveland, O., Oliver C. Schroeder
Columbus, O., Hall Electric Co.
Coraopolis, Pa., T. C. O'Donovan
Cumberland, Md., J. A. Fulton & Co.
Dallas, Tex., Huey & Philip Hdwre Co.
Dallas, Tex., Southwest Radio Supply Co.
Dallas, Tex., Radio Equipment Co.
Dayton, Ohio, Wilkie News Company
Denton, Tex., Evers Hardware Co.
Denver, Colo., Electrical Auto App. Co.
Denver, Colo., Pratt Book Store
Denver, Colo., Reynolds Radio Co.
Des Moines, Ia., H. W. King
Des Moines, Ia., Iowa Radio Co.
Detroit, Mich., Federal Elec. Supply Co.
Detroit, Mich., Twentieth Cen. Radio Co.
Detroit, Mich., Crowley Milner Co.
Detroit, Mich., McCaulay Brothers
Detroit, Mich., Detroit Electric Co.
Duluth, Minn., Kelley Duluth Co.
Easton, Pa., F. & W. Grand Stores
Edgerton Alta. Can., Diller Book Co.
Eureka, Ill., Klaus Radio Co.
Fergus Falls, Minn., Grande & Sether
Flushing, L. I., The Electric Shop
Fort Worth, Tex., H. C. Meacham Co.
Galveston, Tex., Galveston Wireless Sup. Co.
Gardner, Mass., Gardner Hardware Co.
Gloucester, N. J., Lenney's Variety Store
Granite City, Ill., Rosenberg Dept. Store
Great Bend, Kans., Grt. Bend Radio El. Co.
Greensburg, Pa., H. Hamilton
Hamilton, O., Radio Co.
Hartford, Conn., Elec. Sup. & Equip. Co.
Hartford, Conn., F. & W. Grand Stores
Havana, Cuba, Diamond News Co.
Havana, Cuba, Liberia De Jose Albele
Helena, Mont., Van Blaricon Co.
Hoboken, N. J., International Book Store
Holyoke, Mass., Haskell Electric Co.
Honolulu, Hawaii, The Electric Shop
Independence, Mo., Melodian Co. of America
Indianapolis, Ind., Alamo Sales Corp.
Indianapolis, Ind., Capital Radio Sup. Co.
Indianapolis, Ind., Hatfield Electric Co.
Jacksonville, Fla., Southern Electric Co.
Jacksonville, Fla., Holt Electric Co.
Jersey City, N. J., F. & W. Grand Stores
Johnson City, Tenn., Bishop Electric Co.
Kansas City, Mo., Western Radio Co.
Kansas City, Mo., Donaldson Radio & Service Station.
Kansas City, Mo., Vulcanizers Sup. Co.
London, Ont., Can., Wm. Gird & Co.
Los Angeles, Calif., Leo J. Meyberg
Los Angeles, Calif., S. California Elec. Co.
Los Angeles, Calif., West. Radio Elec. Co.
Los Angeles, Calif., Radio Concert & Equip.
Los Angeles, Calif., Natick Book Store
Los Angeles, Calif., Brode Electric Co.
Louisville, Ky., Sutcliffe Company
Lowell, Mass., G. A. Hill Co.
Lyons, Kans., R. I. Case
Macon, Ga., J. W. Burke Co.
Memphis, Tenn., Street Electric Co.
Milwaukee, Wis., Julius Andrae & Co.
Milwaukee, Wis., Dewey Sport Goods Co.
Milwaukee, Wis., Badger Radio Co.
Minneapolis, Minn., Jacob Andreesen Co.
Minneapolis, Minn., Findley Elec. Sup. Co.
Minneapolis, Minn., Nagell Hdwre Co.
Minneapolis, Minn., Reinhard Bro. Co. Inc.
Minneapolis, Minn., Sterling Elec. Co.
Minneapolis, Minn., Peerless Elec. Co.
Missoula, Mont., Missoula Elec. Sup. Co.
Montreal, Can., Milleir & Son, Ltd.
Nashville, Tenn., Zibart Brothers
Newark, N. J., Bamberger & Co.
Newark, N. J., Bassett Radio Sup. Co.
Newark, N. J., Davis Electric Co.
Newark, N. J., Eddies Wireless Ex.
Newark, N. J., S. S. Kresge Co.
Newark, N. J., F. & W. Grand Stores
Newark, N. J., Bannister & Pollard
Newark, N. J., Essex Mfg. Co.
Newark, N. J., W. T. Grant Co.
Newark, N. J., United Elec. Supply Co.
New Brunswick, N. J., Schneider Brothers
New Brunswick, N. J., The Electric Shop
New Orleans, La., Interstate Electric Co.
New Orleans, La., Nola Radio Company
New Orleans, La., Rose Radio Supply Co.
Newport, R. I., George H. Chase
New York City, Con'tal Rad. & El. Sup. Co.
New York City, Fenno & Co.
New York City, Frank Radio Co.
New York City, Fremont Radio Co.
New York City, J. J. Kelleher Elec. Shop
New York City, David Kilioch & Co.
New York City, Liberty Radio Co.
New York City, R. H. Macy & Co.
New York City, Manhattan Elec. Sup. Co.
New York City, Overland Radio & Eq. Co.
New York City, Peerless Light Co.
New York City, Radio Specialty Co.
New York City, Stanley & Patterson
New York City, Viking Radio Co.
New York City, The Winchester Store
New York City, Army & Navy Dist. Co.
New York City, Chamberlain Elec. Co.
New York City, Economy Radio
New York City, Elec. Service Eng. Co.
New York City, Goldfinger Bros.
New York City, Gimbel Bros.
New York City, R. G. Haslinger
New York City, Herbert & Huesgen
New York City, Allied Radio Co.
New York City, American News Co.
New York City, J. Belmuth
New York City, J. H. Bunnell & Co.
New York City, Butler Bros.
New York City, Carnahan & Dalzell, Inc.
New York City, Broadway Radio Corp.
New York City, P. M. Dreyfuss Co., Inc.
New York City, Delta Electric Co.
New York City, Fordham Radio & Spec. Co.
New York City, F. & W. Grand Stores
New York City, J. L. Lewis & Co.
New York City, Lowe Motor Sup. Co.
New York City, Rova Radio Stores
New York City, Live Wire Elec. Co.
New York City, Marks Elec. & Radio Co.
New York City, Modella—8 Stores
New York City, Phillips Sport Shop
New York City, Wehman Bros.
New York City, A. & A. Electric Co.
New York City, Acme Radio Co.
New York City, Am. Elec. Tech. App. Co.
New York City, Atlas Elec. Supply Co.
New York City, Atlas Radio Co.
New York City, Bergmaier Bros.
New York City, Franklin Radio Shop
New York City, J. Gabler
New York City, Globe Radio Shop
New York City, Greenhuts
New York City, Hygrade Electric Co.
New York City, International Radio Store
New York City, J. Kelleher
New York City, Marien Hardware Co.
New York City, Met. Type. & Radio Co.
New York City, Nassau Radio Co.
New York City, Times Sq. Auto Sup. Co.
New York City, Triggers
Niagara Falls, N. Y., Messersmith & Sons
Norristown, Pa., E. M. Law
Oakland, Calif., Warner Brothers
Omaha, Nebr., Wolfe Electric Co.
Omaha, Nebr., Holtz News Co.
Ottawa, Ont., Can., Photographic Stores
Ottawa, Ont., Can., A. H. Jarvis Co.
Pass., N. J., Delta David
Paterson, N. J., Federal Radio & Elec. Co.
Paterson, N. J., F. & W. Grand Stores
Paterson, N. J., S. S. Kresge
Pawtucket, R. I., Delancey Felch & Co.
Philadelphia, Pa., Gimbel Brothers
Philadelphia, Pa., Phila. Wire Sales Corp.
Philadelphia, Pa., H.C.Roberts Elec.Sup.Co.
Philadelphia, Pa., Sayre Level Radio Co.
Philadelphia, Pa., Goetz Music Stores
Philadelphia, Pa., Ross Frankford Mus. Co.
Philadelphia, Pa., F. & W. Grand Stores
Philadelphia, Pa., E. T. Noll & Co.
Philadelphia, Pa., Roberts Bros. Elec. Co.
Philadelphia, Pa., G. W. Snell Co.
Philadelphia, Pa., Eisenberg & Schaeffer
Philadelphia, Pa., W. T. Grant
Philadelphia, Pa., Nelsner Brothers
Philadelphia, Pa., New York Radio Co.
Philadelphia, Pa., Post Cigar Store
Philadelphia, Pa., Schimmel Electric Co.
Phoenix, Ariz., Nielson Radio Sup. Co.
Pittsburgh, Pa., Goldsmith & Sons Co.
Pittsburgh, Pa., Ludwig Hommel & Co.
Pittsburgh, Pa., Gain-a-Day Electric Co.
Pittsburgh, Pa., Liberty Incan. Sup. Co.
Pittsburgh, Pa., Pitta. Radio & App. Co.
Pittsburgh, Pa., U.S. Radio Co. of Penna.
Pittsburgh, Pa., Doubleday Hill Co.
Pittsburgh, Pa., F. & W. Grand Stores
Plainfield, N. J., F. & W. Grand Stores
Plattsburg, N. Y., H. E. Atwater
Portland, Me., L. M. Cleveland Co.
Portland, Me., Chisholm Brothers
Portland, Ore., Stubbs Electric Co.
Portland, Ore., Hynson Electric Co.
Pottstown, Pa., Pottstown Radio Sup. Co.
Providence, R. I., Union Electric Sup. Co.
Providence, R. I., R.I. Elec. Equip. Co.
Providence, R. I., F. & W. Grand Stores
Providence, R. I., B. & H. Supply Co.
Reading, Pa., F. & W. Grand Stores
Rochester, N. Y., Hickson Elec. Co.
Rochester, N. Y., Rochester Elec. Sup. Co.
Rochester, N. Y., Wheeler Green El.Sup.Co.
Rochester, N. Y., Eastman Radio Co.
Rochester, N. Y., B. Schmidt & Co.
Rochester, N. Y., E. C. Sykes & Co.
Rochester, N. Y., Nelsner Brothers
Rock Island, Ill., H. E. Gelhart & Co.
Rock Island, Ill., Beardsley Specialty Co.
Rock Island, Ill., Valie Co.
St. Joseph, Mo., Empire Electric Co.
St. Joseph, Mo., Mannschrecks Book Store
St. Louis, Mo., The Benwood Co.
St. Louis, Mo., Fuetterer Battery Service
St. Louis, Mo., Linze Electric Supply Co.
St. Louis, Mo., Ernest Electric Co.
St. Louis, Mo., Foster Book & Cigar Co.
St. Louis, Mo., Security Auto Supply Co.
St. Louis, Mo., Stewarts
St. Paul, Minn., North-West Elec. Eq. Co.
St. Paul, Minn., Premier Radio Mfg. Co.
St. Paul, Minn., Pioneer Electric Co.
St. Paul, Minn., St. Paul Book & Sta. Co.
St. Paul, Minn., Crist Book Shop
Salem Mass., Salem Plumb. & Lgt. Sup.Co.
Salisbury, N.C., T. M. Casey's Elec. Shop
San Francisco, Calif., Leo J. Meyberg Co.
San Francisco, Calif., Conrad Richter
Schenectady, N. Y., Finch & Hahn
Seattle, Wash., Northern Radio & Elec. Co.
Seattle, Wash., Northwest Radio Service
Seattle, Wash., Archway Book Store
Seattle, Wash., Williamson Electric Co.
Shanghai, China, E. Evans & Son, Ltd.
Shreveport, La., Interstate Electric Co.
Spartanburg, S. C., Brill Electric Co.
Springfield, Mass., Whitall Electric Co.
Stamford, Conn., Fairbanks Electric Co.
Stamford, Conn., Arthoen
Stillwater, Okla., Stillwater Electric Shop
Sydney, Australia, N. S. W. Bookstall
Syracuse, N. Y., Hughes Electric Corp.
Syracuse, N. Y., Alexander Grant Sons
Tacoma, Wash., W.A. Mullens Electric Co.
Terre Haute, Ind., National Auto Sup. Co.
Toledo, Ohio, Kuebler Radio Co.
Toledo, Ohio, W. J. Nagel Electric Co.
Toronto, Ont., Can., T. Eaton, Ltd.
Trenton, N. J., Radio Chain Stores
Trenton, N. J., M. M. Fieron & Son, Inc.
Troy, N. Y., F. & W. Grand Stores
Tyler, Tex., R. E. Bryan
Union Hill, N. J., N. W. Friedman
Uniontown, Pa., Frederick Piano Co.
Utica, N. Y., M. F. Dent Co.
Utica, N. Y., Utica Electric App. Co.
Waco, Tex., Jackson's Radio Eng. Lab.
Washington, D. C., Harry C. Grove, Inc.
Washington, D. C., National Radio Institute
Washington, D.C., Con'tal Elec. & Sup. Co.
Watertown, Wisc., D. & F. Kusel Co.
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Wilkes-Barre, Pa., Foster Radio&Elec. Co.
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Including Two Interchangeable Inductance Coils

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Trade Mark

TUBE SET

(Model GT-1)

CLARITY ***VOLUME*** ***DISTANCE*** ***SIMPLICITY*** ***ECONOMY***

For many months our radio engineers have been exerting their efforts toward developing the ideal tube set. They knew that millions of homes would welcome the low priced instrument that embodied simplicity of operation with a minimum cost of up-keep. They wanted an instrument that would bring in volume and distance, clear and loud, **with a single control,** an instrument that would be classed as a work of art, the possession of which anyone would be proud. That their untiring efforts have been crowned with success is now certain.

The NATIONAL **MONODYNE** TUBE AIRPHONE includes all these features and more.

The **MONODYNE** CIRCUIT is one of the most radical advances in radio engineering since the advent of the Armstrong Circuit. Parts heretofore considered essential are omitted and one simple tuning control gives a selectivity equal, if not superior, to that of sets costing hundreds of dollars. A child can operate it.

SIMPLICITY

The NATIONAL **MONODYNE** uses but one dry cell tube, preferably the WD-12 or any other standard dry cell tube, such as the UV-199 or C-299 types. Local broadcasting comes in astonishingly loud and clear, without distortion.

The tube socket is of a new design and most practical because it holds the tube with a positive grip on all four prongs for a depth of more than one-quarter of an inch.

The NATIONAL **MONODYNE** AIRPHONE will find especial favor with experimenters because of its adaptability in many different hook-ups, a thing not possible with any other low priced outfit.

LONG DISTANCE

In our New York laboratory tests, we repeatedly heard stations KYW at Chicago, WOC at Davenport, Iowa, and many others, quite loud and clear. This without resorting to any mode of amplification.

The NATIONAL **MONODYNE** is the most practical tube set made, and is complete in all details. It is only 6½ inches long, 4¼ inches wide, and 2¾ inches high of durable, compact and rugged construction. The entire casing is moulded from hard rubber composition.

The NATIONAL **MONODYNE** has a receiving capacity and range of about 1500 miles. 75-foot aerial is recommended for best results.

ALL WAVE LENGTHS

With the outfit are furnished two interchangeable fixed double inductance coils for various wave lengths, ranging from 200 to 600 meters.

THE IDEAL VACATION SET

DISTRIBUTORS—Write for Territory. DEALERS—For Price List.

NATIONAL AIRPHONE CORPORATION

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SEND NO MONEY

COUPON B.N.-8

National Airphone Corporation,
18 Hudson Street, New York City, N. Y.

Gentlemen:

Please send me prepaid One (1) NATIONAL **MONODYNE** tube set, Model GT-1, for which I will pay the postman $10.00.

If within five days I do not find the apparatus all you claim for it, I may return same to you in good condition and you will refund the full purchase price.

NAME .....

STREET AND NO. .....

CITY ..... STATE .....

"Sorry, old man, I don't know enough about radio; you'd better ask _____"

(Can YOUR Name be put here?)

Is your knowledge of radio limited? Do you have to go to others for advice?

Or are you recognized as an authority? Do your friends come to YOU?

Learn Radio the Kenneth Harkness Way

YOU ought to have such a comprehensive knowledge of the whole subject of radio reception that you are never at a loss, and can solve immediately all practical and technical problems.

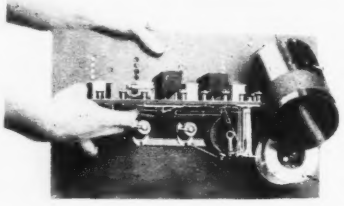
You might gain this knowledge by spending years in experimentation; by wading through hundreds of abstruse mathematical treatises you may eventually piece together the knowledge you are seeking. Others *had* to take this course, but

There is a New and Simpler Method Open to You

In his lucid, entertaining style, Kenneth Harkness makes the whole subject of radio reception as clear as day in his new book "The Theory & Practice of RADIO FREQUENCY AMPLIFICATION" just off the press.

Mr. Harkness is one of the foremost radio authorities in the country particularly as a specialist on radio frequency amplification. His clarity of expression; the easily understood manner in which he explains even the most complicated phases of the theory of radio have made him internationally known as "the exponent of advanced radio in everyday language."

The book covers the entire subject of radio reception, from its elementary laws to its advanced principles. Radio frequency amplification—the most modern development—is explained in detail. No previous knowledge is necessary for a thorough mastery of this book.



One of the monographs from Kenneth Harkness' book showing the construction of a receiver.

Build Your Sets the Harkness Way

The Radio Guild, Inc., pioneer manufacturers of radio frequency amplifying apparatus, have granted permission to the author to reveal in this book the design, construction and wiring of several different types of their famous receivers. Some of the sets are already on the market; others have just been developed in the laboratories of the Radio Guild and are disclosed by Mr. Harkness for the first time.

The assembly and construction are explained thoroughly and illustrated by scores of diagrams, mechanical drawings and action photographs. The combination of text and illustrations unfolds each consecutive step in the construction of these receivers with the graphic clearness of a moving picture. Nothing like this has ever been published before.

Mr. Harkness writes with a background of years of vivid, colorful experience. As a manufacturer, hundreds of receivers have passed through his hands and the practical knowledge he has gained of operation design, assembly and trouble-shooting is now at your disposal.

Nothing we can say will describe the pleasure and instruction you will derive from reading this latest and most comprehensive work on radio reception.

Mail the coupon below NOW and receive your copy in return. SEND NO MONEY—simply mail the coupon. When the book arrives pay the postman only $1.00 plus a few cents postage.

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To induce prompt action on your part, the senders of the first five hundred coupons received by us will be given the opportunity of obtaining, at the astonishingly low price of $1.25, the two books "The Theory and Practice of RADIO FREQUENCY AMPLIFICATION" and "The Construction and Operation of Super-Regenerative Receivers," both by the same author. The latter book is now in its third edition.

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Please send my copies of "The Theory & Practice of Radio Frequency Amplification" and "The Construction and Operation of Super-Regenerative Receivers" by Kenneth Harkness. I will pay the postman $1.25 plus a few cents postage upon delivery.

(Note: If you do not want the book on super-regeneration, check here ☐ and upon delivery pay the above price less 25c.)

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The Radio Guild, Inc.

256 West 34th Street

New York, N. Y.

Specialists in Radio-Frequency Amplification

How many of these questions can YOU answer?

1. What is the difference between A.C. and D.C. current?
2. What are the principles of radio telephony?
3. Why is a rectifier used and what are the principles of its operation?
4. What does "heterodyne" mean? When is this system used in a radio receiver?
5. Can you give a full and detailed explanation of the effects of "inductance" and "capacity" in an A.C. circuit?
6. Can you briefly contrast the effects of inductance reactance and capacity reactance in an A.C. circuit?
7. What are the principles of resonance?
8. Can you define "mutual induction?" What effect does "coupling" have upon the resonance curve of coupled oscillatory circuits?
9. Why does an audio-frequency transformer have a very close coupling and a radio-frequency transformer a very loose coupling?
10. What effect has a coupling variation upon the audibility and selectivity of an inductively coupled receiver?
11. Can you explain the operation of a vacuum tube as a rectifier—as an amplifier—as an oscillator?
12. Can you explain in detail all the factors that enter into the design of a radio-frequency transformer in a multi-stage radio-frequency amplifier?
13. Do you know the process of manufacturing a radio-frequency transformer—the different stages of its construction?
14. Why is a loop directional? When should it be used?
15. Do you know the principles underlying a new type of tuner for radio-frequency amplifying receivers which ensures selectivity better than a loop but with much greater receiving range?
16. Do you know how to construct a complete receiver with two stages radio, detector and three stages of audio-frequency amplification? This set is so sensitive it picks up stations a thousand miles away on a loop.
17. Do you know how to construct a tuner and radio-frequency amplifier (2 stages) which can be used with any standard receiving set to increase its sensitivity or with a detector and audio-frequency amplifier? This set has a single switch to completely cut out the r.f. amplifier when it is not required.
18. Do you know how to make a high-frequency oscillator to cover all wave lengths?
19. Do you know how to make a simple one tube receiver which is so sensitive that it will operate a loudspeaker well and receive long distances?

Don't even try to answer the last question! If you haven't read the new book by Kenneth Harkness you don't know about this new set which has just been developed in the laboratories of the Radio Guild. Read about it and then judge for yourself. Two other sets built on the same NEW principle as the one tube set but even more sensitive are also described by Mr. Harkness. All the above questions and hundreds more are answered in detail in this amazing book. MAIL THE COUPON *TODAY* AND GET YOUR COPY IMMEDIATELY!

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(*Continued from page* 176)

munity. To one who had so far found plenty of uses for all his time, the long days of inactivity added nothing to his native good nature, which developed a longing for something to occupy his time.

Now, Uncle George had two sons who were very diligently following in Father's footsteps out in the great steel mills. One day these thoughtful boys sent him a first-class radio receiver and in due time, with not a little skepticism, the father erected an aerial and installed the set in his study.

Of course it did not work perfectly at first, but with a little perseverance that clinched the old gentleman's interest, reception came in quite clearly from many of the Eastern and Western broadcasting stations. I have seen the most delightful twinkle creep into Uncle George's blue eyes when he succeeded in tuning in some particularly distant station; yes, a twinkle and a fire that his old friends thought had died out many years before. So in Uncle George's household an entirely new era began. His house became the popular evening rendezvous for young and old. He began with three tubes in the receiver, and headphones; these satisfied him for a time, then he wanted to share his great joy with his neighbors, so he next added an amplifier and a loud speaker, and then there was fun for all; the results were amazing.

A thing that worried them was that perhaps some time when he was listening in (as one does on the party telephone line) he might pick up something that was going on in their own homes and that would never do. But a new sociability had been created; a new topic of conversation had come into the community and to its credit, be it said, replaced much of the former small talk of the town gossips that smouldered around the stove of the village grocery store, or the postoffice, or any of the chief gossiping centers.

Dances were given to music that came from well nigh a hundred miles away, wonderfully clear, living music that had never been heard in that part of the world before. Lectures by famous orators, talks on health, education, thrift, politics and little journeys into the homes of the great. Sketches from the "hits" of Broadway, and big musical productions; fine sermons on Sunday from city churches with music from the choir that made his old heart throb the faster. Talks to the farmer were broadcast on better farms, and a general market report of the day; with these and the weather forecast and time signals, he had about every thing he could possibly desire.

"Uncle George" certainly was popular; some farmer friends miles out in the hills came in to see and hear the new *Radiator*, as they called it, and very soon they heard "This is WJZ, broadcasting from the Waldorf-Astoria studio, New York City," words could not express their surprise and astonishment. One old farmer recollected that 15 years before he had been in that same old Waldorf-Astoria Hotel

There was a general consultation about this radio, in which most of them expressed their doubts. Their farmer friend said, "They do great stunts in New York City," and went on to tell his experiences when he stopped at that same hotel, but they were not going to take his word, and there was an earnest inquiry as to what was what. So, after many evenings of listening in, each one said he would have one of those things if it took the last cow on the farm to buy it.

Now, fancy what a miracle had happened to these farmers, who had never really been to a big city, and whose thoughts were never permitted to wander any further away than the pig pen, or cow stable, to suddenly come in from the fields, switch on the current in a radio receiver, get the price of wheat, the farm and market report direct, and then the

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Radio "A," "B" and "C" BATTERIES

How often has your triumph in getting a distant signal been short-lived because of your inability to *hold* the signal? The batteries—have you looked there for the trouble? Get the best. Fine tuning requires batteries that are *even*-powered as well as full-powered. Westinghouse Batteries are built with that very important point in mind. They are as steady, even-discharging, noiseless as the highest radio and battery engineering can make them. And once you're equipped with Westinghouse Batteries your battery expense is virtually ended; they'll last indefinitely—can be easily, repeatedly and economically re-charged.

At radio dealers and Westinghouse Battery Service Stations everywhere. Write for illustrated folder.

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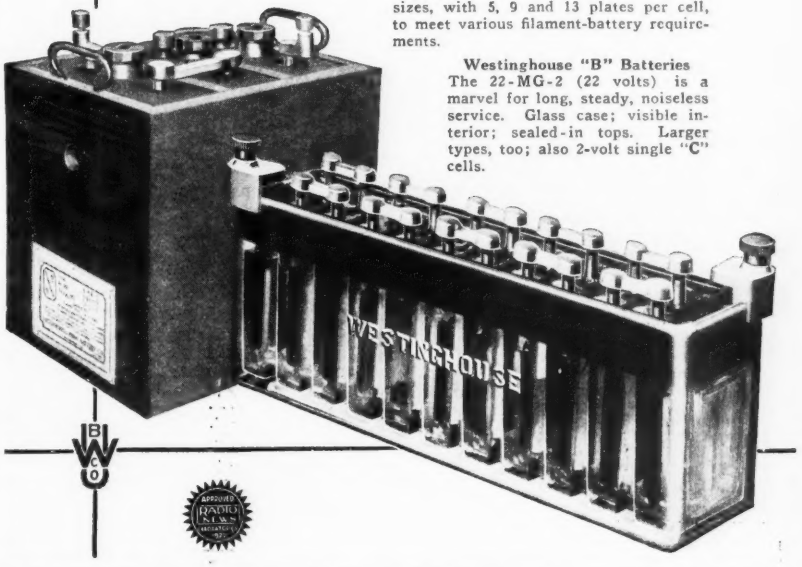
Swissvale, Pa.

Westinghouse "A" Batteries are full-capacity, slow-discharge, long-life batteries. Made in 4, 6 and 8 volt sizes, with 5, 9 and 13 plates per cell, to meet various filament-battery requirements.

Westinghouse "B" Batteries The 22-MG-2 (22 volts) is a marvel for long, steady, noiseless service. Glass case; visible interior; sealed-in tops. Larger types, too; also 2-volt single "C" cells.



Give Your Crystal Set A Fair Chance

A Crystal set, when properly equipped, is the ideal method of radio reproduction—clear, musical, economical. But the best crystal set ever made will not reproduce properly with a poor crystal.

M.P.M. (Million Point Mineral) Crystal

has made the Crystal Set successful. Unsolicited testimonials are constantly being received, reporting records up to 1200 miles. Don't discard your Crystal Set until you have given "M.P.M." a trial. Send 25c and name of your radio dealer for sample unmounted crystal. 35c for mounted. Insist upon M.P.M.

MPM — MILLION POINT MINERAL — THE WORLD'S GREATEST RADIO CRYSTAL

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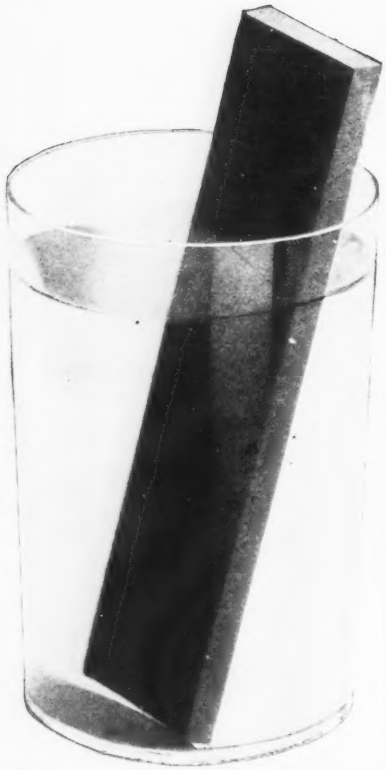

WATER

Water is a good conductor of electrical currents. When a panel absorbs moisture it loses a good part of its insulation value—it permits leaks and short circuits—it damages reception.

Radion Panels are impervious to water. Even if immersed in water they positively could not absorb enough moisture to injure reception results. That's one of several reasons why Radion is the supreme insulation for wireless use.

18 STOCK SIZE PANELS

Radion, being an insulation material especially made for wireless use, has the lowest phase angle difference, lowest dielectric constant, highest resistivity and supreme moisture, gas and acid repelling properties.

Panels, Dials, Knobs, V. T. Sockets, Antenna Insulators, Phone Caps, Etc.

American Hard Rubber Co.,
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RADION

"The Supreme Insulation"

weather forecast for the next 48 hours. This last was a valuable bit of information; hundreds of crops could be saved with this advanced knowledge. It meant that they should plant or should not plant the following day. I tell you, when a farmer has been at work all day in the fields, he needs a complete relaxation in the evening; his mental faculties just itch for some diversion, something to listen to. He wants to hear the news of the day, to get in closer touch with the world. We all grow tired of routine. The local newspaper is soon read and the small gossip of the supper table is usually exhausted with the desert.

In the city when our day's work is done and we want amusement and diversion, we can very easily buy it; we are within a stone's throw of the "gay white way," where tickets may be bought for the movies, the latest Broadway hits, concerts, and lectures. We have such a variety to choose from, I sometimes feel we have lost the ancient grace of creating our own amusements. We have the preference of listening in, or going out direct to the places from which they are broadcasting. So you see it is not only a luxury in the country to have Radio, but a real *necessity*. If we are to remain *one* of the leading agricultural countries of the world, we must keep the farmer and the old homestead a living reality; together they are the meal ticket of the country and without their efforts we cannot live.

"How can you keep them down on the farm?" There is more truth than poetry in this old song. We are not going to do it entirely by giving the farmers more credit, and bigger profits on their crops, which would satisfy them for a while. The younger generation is looking at it from another point of view. Maybe it was spring time when you passed along and the tinkle of a bell arrested your attention as you observed a prim little school ma'am gather her flock to their studies, 30 or 40 of them, fine healthy to-morrow's citizens; little tots, and fine stalwart chaps, who could handle a plow as well as their fathers. Maybe you wondered as you drove on past the widely scattered farms why it was that out there, where everything was so fresh and fine, and so much profitable work was to be done, there was always a lack of hands to do it?

Where are those same school boys and girls of five years ago? You can look for most of them in some congested manufacturing center, such as the steel mills of Pittsburgh, or the cotton mills on the coast, or in some big city floating along with the masses, ekeing out a mere existence. They have traded their birthright for a meager day to day existence, and for what? For just one thing and that is to be in touch with the world. That means life, music, theaters, dances, concerts, and associating with people of mutual interests. Man is a social animal and can not bear to live alone any great length of time.

This wonderful gift of Radio, together with the cheap and practicable automobile, will do more to correct the above mentioned condition than anything else in the world. I believe it is particularly for those away out in the silent hills, and small country districts. Radio reception is more nearly perfect there and access is had to a far greater distance and selection. I represent myself as one who has enjoyed radio reception both in the heart of New York and in the rolling hills, and let me tell you my Radio set was worth 100 per cent more to me in the hills than when I was within rifle-shot range of a broadcasting station. And it is to this point of view that I wish to call your attention; to where this vast field of Radio is most needed, and I am sure it will be appreciated and will accomplish a world of good. This great land of ours will always continue to be great so long as its agrarian population, as in the past, remains the backbone of America.

Now you Sons and Daughters of the farm who have long ago drifted away from the old homestead, and left the old folks in utter loneliness, don't you think it would be a fine surprise to deny yourself a few pleasures, and with money thus saved buy them one of those *Radiators* that Uncle George and his friends are enjoying to-night?

Short Wave Directive Radio Transmission

(*Continued from page* 130)

and stone construction. Although a large deflection was obtained on the galvanometer just before entering the doorway, the deflection became zero as soon as the apparatus was placed inside the door. Quite a reduction in the received current was noticed whenever any large object was in the path of the transmitted waves.

Telephony of very good quality was accomplished by using the circuit shown in Fig. 13. This circuit employs constant current modulation and was found to give excellent results. The use of telephony facilitated the making of observations at a distance.

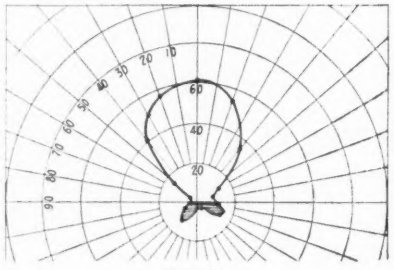


Fig. 12

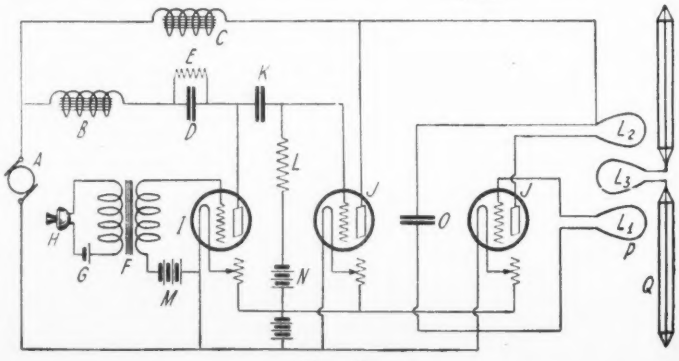
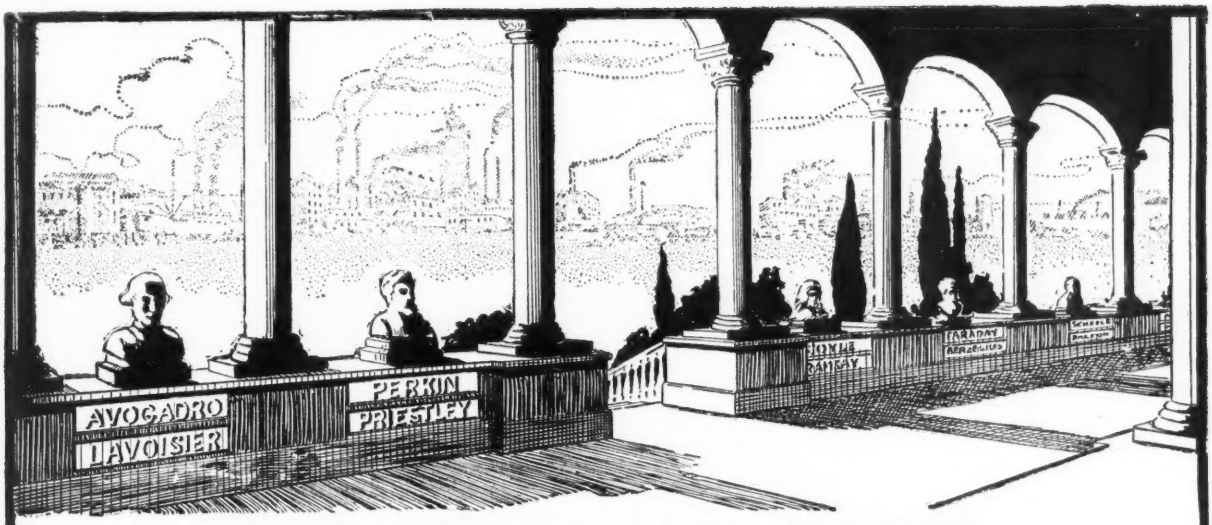


Fig. 13. Showing Effect of Removing the 10 Reflecting Wires Nearest the Vertex of the Parabola. A Schematic Drawing of a 10-Meter Radiophone Transmitting Set is Shown on the Right.



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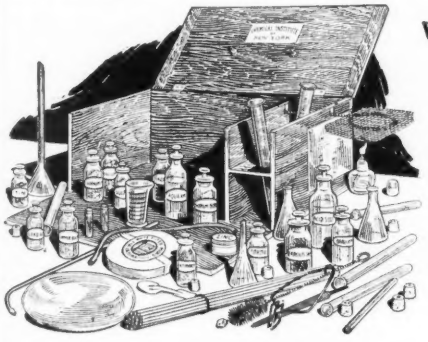

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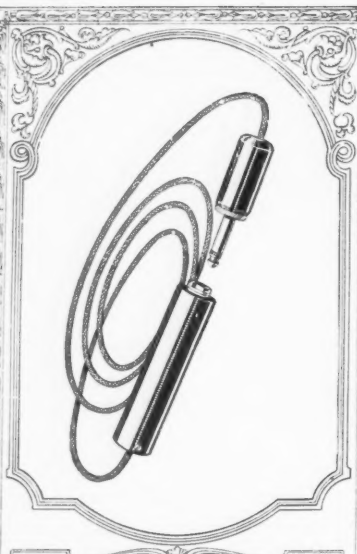

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In conclusion, it may be said that directive radio communication on short wavelengths, employing the type of apparatus described, has been found to be practicable and to merit much more comprehensive investigation and use. Its great advantages are apparent, especially for certain classes of communication and specialized work, and it is very probable that its development and use will be one of the future problems for the radio engineers.

Page the Amateurs

(Continued from page 131)

ducers most interested is experienced. It is seen that with the use of radio, these producers may have a current moving picture of the entire situation and use it effectively in planning shipments to market, a service that would also benefit consumers through stabilization of market supplies.

To Z. R. Pettet, Agricultural Statistician at Atlanta, Georgia, belongs the credit for demonstrating the practicability of radio in crop work. His quick action in the frost emergency and the satisfactory results obtained have convinced his superiors at Washington headquarters of the possibilities of radio along general crop-reporting lines as well as in emergency work. Development of a nation-wide service that will make crop news quickly available is now under way. General reports will be rendered by radio telephony, but for information that may have a speculative effect on market prices radio telegraphy and amateur operators will be used.

Once there was an amateur operator who made a quick survey of the radio field and decided that his end was near. At each new radio development his gloom darkened. Then lo! Light dawned. Rather than to diminish the scope of his activities he saw that the new developments tended to accentuate his importance. His possibilities of usefulness were greater than ever before. Particularly in agriculture is this true. Amateurs, stand by!

Radio Frequency Receiver Design

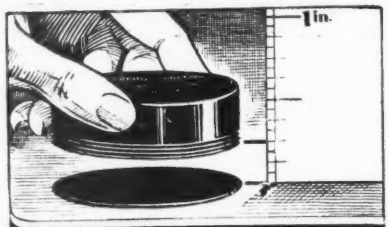
(Continued from page 153)

but again the most important controls are the secondary condenser and the potentiometer. The coupling only requires adjustment when interference is experienced.

LOADING COILS MAY BE INCLUDED

The receiver is also provided with binding posts for the inclusion of loading coils, if it is desired to receive on higher wave-lengths. These binding-posts appear on the top left hand side of the front panel in the photo. The loading coils may consist of duo-lateral coils very loosely coupled together. An additional variable condenser would also be required in series with the ground to tune the antenna circuit. Different radio frequency transformers would be necessary to amplify these higher waves.

The construction of a receiver of this type should not be a formidable task for the radio amateur, especially with the assistance of the photographs here published, which show in detail the apparatus and its disposition, together with the wiring diagram of Fig. 1. The dimensions of the front panel are 17½"x10½" and those of the shelf panel are 8" wide by 7¾" deep.



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Each article submitted must narrate the personal experiences and experiments of the writer in securing distant stations, in avoiding interference and distortion, and in securing volume and clearness of reception. Wiring diagrams showing the hook-ups used to secure these results will add greatly to the value of the article. No article shall exceed five hundred words.

Radio and audio frequency transformers of any make or brand will be eligible. The contest starts June first and ends September thirtieth. In case of a tie, each tieing contestant will receive the full amount of the prize. All articles must bear a postmark of not later than October first. Do not stay out of the contest for fear that you are not an "expert." A novice with natural mechanical or electrical ability may hit on a combination which will win the first prize —$250.00 in cash. Send the coupon or apply to any radio dealer to secure the four page folder explaining complete details of contest, the judges, the prizes to be given, etc.

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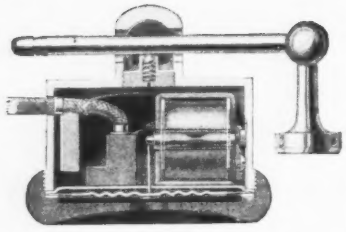

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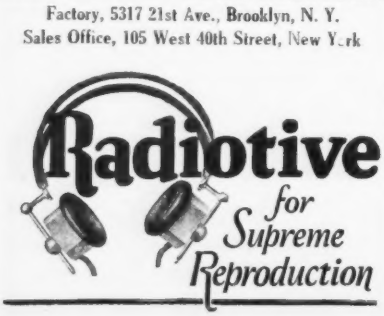

What Happens to the Speech and Music When Broadcast

(*Continued from page* 143)

The radio frequency currents which are generated by the vacuum tube transmitter are transferred to the antenna by means of electrical circuits. When these currents flow up and down in the antenna, radio waves are produced which then travel outward. However, in the state in which they then are, they cannot do anything as far as speech goes; they are merely in a position to carry along with them any speech signals which are impressed on them. The reader should remember that these waves, generated in the antenna by the radio frequency generator, are merely the agents for transporting the speech to distant points, for speech currents cannot travel alone through space. They are the speech carriers, or "carrier waves" as they are called.

So far, we have magnified faithfully the original speech or sounds which left the performer's mouth until the magnified current is many hundred times stronger than the original speech current, and we have generated the radio frequency waves which are waiting to transport the speech to distant points. In order that the radio frequency waves be able to carry these speech currents most efficiently, it is necessary that the speech currents be magnified and properly impressed on the radio frequency carrier waves. If the speech currents are not sufficiently magnified the carrier waves will not transport them as far as they would otherwise. Furthermore, unless the speech currents are properly impressed on the carrier waves they will not be transported and if they are, they may be very badly distorted, so that the person receiving the signals will hardly be able to recognize the sounds.

THE MODULATOR CIRCUIT

In order to properly impress the speech currents on the carrier waves, a special circuit must be employed called the "modulator circuit," which again employs that versatile instrument, the vacuum tube. This modulator circuit places the speech current on the carrier wave in the proper manner so that the latter will transport the speech most efficiently and without distortion. However, in order that this be properly done, the speech currents must be amplified a certain amount. The strength of the speech current when it emerges from the speech amplifier (where we last left it) is not sufficient for this. Hence another vacuum tube amplifier is employed called the "modulation amplifier." The speech currents which leave the speech amplifier are then passd through this modulation amplifier. The speech currents are now magnified to a sufficient value where they are able to be passed through the modulator tubes, of which there are as many as there are radio frequency oscillator tubes. When the speech current finally leaves these modulator tubes they are sufficiently strong to modify the radio carrier waves, which then transport them through space.

Throughout all these various operations through which the speech passes, one important thing must be avoided, namely, distortion. It is easily seen that there are many chances for the speech currents to be altered ever so little, so that they will deviate from their original true form. But if this happens, the music which we receive may be nothing more than discord. The various circuits are therefore most carefully designed so that nothing untoward may happen to these sound currents, and so that they are finally hurled out from the antenna into space in their original state.

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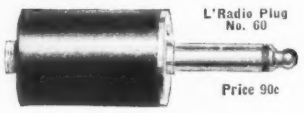

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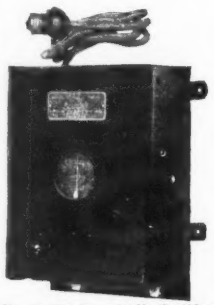

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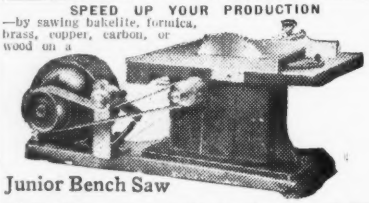

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V-DE-CO RADIO MFG. CO.

ASBURY PARK, N. J.

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ond, a radio frequency wave which is carrying with it some song or concert or lecture. As it travels through space it gets weaker and weaker, the farther away it gets from the antenna. In its travels through space, the wave strikes a number of antennæ which are on the lookout for it, by being tuned to its frequency, and these antennæ snatch from the wave a portion of its energy, but only a very thin portion, for after the wave has passed through space it has not much energy left in it. Yet this tiny energy is sufficient to bring the sounds in loudly and clearly.

The radio wave carrying with it the speech currents flows down the receiving antenna and into the receiver. Probably with this wave there are a number of other waves also clamoring to get into the receiver. Unless these other waves are shut out, the signals will be a hodge-podge because all these waves are contributing their little speeches which together do not make much sense or music. By properly tuning the receiver we shut the door of the receiver in the face of these interfering waves, but permit the wave we want to sneak in, as it were, through a trap door.

We now have in our receiver the radio waves which have carried with them the speech or music currents which we want to hear. But the energy in these waves is now extremely minute for they have had to travel a long way and in their travel they have lost some in the atmosphere, some while traveling through houses and perhaps across mountains, and much of their energy has been stolen by other antennæ, which have been on the lookout for them. So that there may be as little energy left in them now as there was originally in the voice of the performer which was, as we saw, ridiculously small. We must, therefore, magnify the energy in the received wave so that we will be able to hear it. This is done by means of the "radio frequency amplifier," which employs the vacuum tube to increase the strength of the received energy. Here again, as in the case when the speech was being transmitted, we must be very careful not to alter or distort the speech. By using the proper kind of tubes and the proper kind of electrical circuits we are able to magnify the energy sufficiently without distorting the speech which has been carried along.

However, we cannot hear the music or speech yet because it is still in the grip, we might say, of the radio frequency carrier wave. All we wanted the radio frequency wave for was to carry the speech currents to the receiver. Now that it has carried the speech currents to the receiver we have no further use for it. We therefore pass these magnified waves through a "detector," which may be again a vacuum tube or sometimes a crystal mineral, which separates the speech currents from the radio currents, and passes these speech currents to the telephones. We now have our original speech currents which were transmitted from the broadcasting studio in the telephones and the original sounds are heard, just as a conversation is heard when the speech currents flow in the receiver of your desk telephone.

It is possible that the sounds heard in the telephones are weak, for the waves may have had to travel so far that less energy was left in them than we imagined. Or it may be that the sounds heard are loud enough to be heard by the person wearing the telephones, but not loud enough to be heard by other people in the same room. These received signals or sounds may be increased in volume by using an "audio frequency" amplifier to amplify the sounds so that they are stronger. This audio frequency amplifier corresponds exactly with the speech amplifier employed at the transmitter to increase the intensity of the speech currents. By amplifying the signals this way, they may be made loud enough to be passed through a special telephone called a "loud speaker" which will fill a room with the music or lecture.

The original sounds have had to pass over long distances, through many obstacles, and through many operations to reach their final destination, pure and undistorted, true and faithful to the original sounds which left the mouth of the performer. It may be said that eternal vigilance is the price of this achievement.

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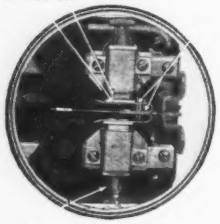

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With the Sea-going Operators

(*Continued from page* 167)

Board and by Gibbs Brothers, the Naval Architects who have charge of reconditioning the ship and all expressed themselves as entirely pleased with the installation and performance.

At sea, the operator who is assigned to this boat will have charge of the installation and probably will be required to send out test signals about once a week on both 300 and 600 meters. It will probably be interesting for amateurs to listen in for these test signals provided they are sent out at a prearranged time.

Calls Heard

(*Continued from page* 174)

WGY, WHA, WHAB, WHAH, WHAS, WHB, WHX, WHZ, WIAO, WIAS, WIAR, WJAB, WJAD, WJAH, WJAX, WKAA, WKAF, WKAL, WKY, WLAB, WLAG, WLAJ, WLAL, WLB, WLK, WLW, WMAK, WMB, WMC, WNAD, WNAS, NY, WOAA, WOAC, WOAI, WOAN, WOAO, WOAW, WOAZ, WOC, WOI, WOK, WOQ, WOS, WPA, WPE, WPAC, WPAD, WPAH, WRR, WRAP, WSAS, WSB, WSY, WTAW, WTK, WUZ, WWAC, WWAY, WWI, WWJ, PWX, and Frank H. Jones, somewhere in Cuba.

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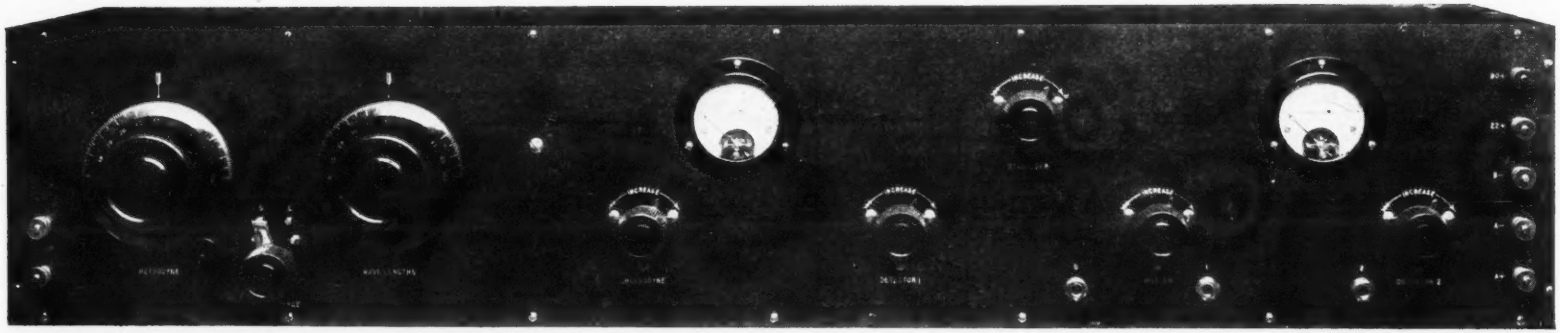

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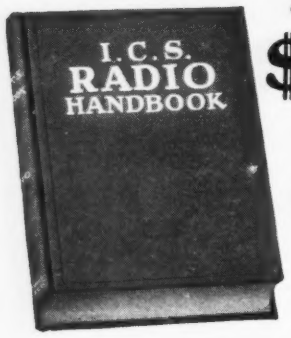

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Phone—1SN, 9XU.

Canadian—1BQ, bunch of 2's, 3CG, 3CO, 3CQ, 3FO, 3GE, 3GK, 3HE, 3IN, 3JL, 3KO, (3NI), 3OJ, (3PG), 3TA, 3TR, (3XN), (3ZS), (9AL), 9BJ, 9BV, 9BY, 9ZT.

New Radio Patents

(*Continued from page* 166)

radiation is materially increased. A system of this character, designated by the illustrated circuit diagram, is claimed to be of such arrangement as to lengthen the distance of the transmission of signals such as wireless telephone, without distortion, to a distance greater than has heretofore been obtained with simple non-complicated circuits. The invention consists, substantially, in the combination, construction, location and relative arrangement of parts and circuits employed in connection therewith.

RADIO APPARATUS

(Patent 1,437,772, issued to John B. Nowlan, of Denver, Colo., Dec. 5, 1922.)

The object of this invention is to provide a radio receiving apparatus of high selectivity whereby signals transmitted on adjacent wave-lengths may be received and isolated for reproduction without undue interference.

The radio receiving apparatus of the present invention comprises an insulated panel carrying the radio equipment supported on the rear thereof and housed within a cabinet. The apparatus includes a radiofrequency oscillating circuit which may be an antenna ground circuit or a coil collector circuit or a ground system balanced against a free ended extended conductor. The oscillation circuit shown in the drawings includes a primary inductance tapped at selected points to switch contacts whereby the desired amount of inductance may be included in the oscillating circuit.

Inductively associated with the primary winding are two coupling coils, arranged at opposite ends of the primary inductance and adjustably mounted with relation to the primary inductance. One of the coupling coils forms the secondary and carries an inductance tapped at selected intervals and

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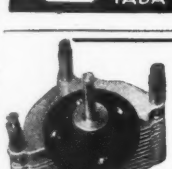

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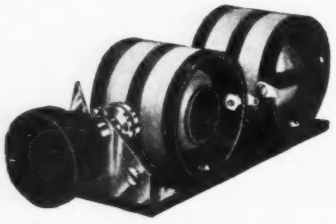

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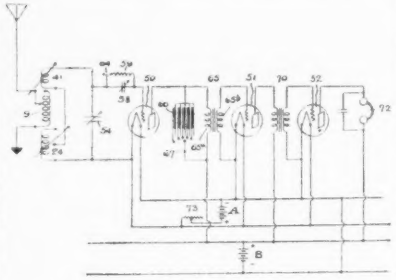
arranged with a mechanical switch and position-varying means whereby the period and coupling of the circuit associated with the coupling coil may be varied. By means of this secondary coupling coil, broad adjustment of coupling between the circuits is secured. There is provided a vernier adjustment coil series connected with the broad adjustment coil whereby accurate adjustment in coupling between the circuit including the primary inductance and the secondary receiving circuit is secured. The vernier coil is constructed of small inductance relatively to the inductance of the broad adjustment coil. The coupled circuit including the broad adjustment coil and the vernier adjustment is provided with tuning means and connected to an electron tube detector circuit. A selective bypass condenser is connected in the



output circuit of the detector tube in shunt with the primary winding of an audio frequency transformer, the secondary of which connects to the input circuit of a multistage audio frequency electron tube amplifier. All of the tubes have their filament circuits and plate circuits supplied from common A and B batteries. On the receiver panel of the apparatus there are provided connections for loading the primary inductance, the broad adjustment secondary coupling coil and the vernier coupling coil.

The grid condenser employed in the grid circuit of the electron tube detector is of the variable type and a switch is provided on the receiver for selectivity, cutting out the grid leak or connecting the grid leak in shunt with the grid condenser. The panel is also provided with connections and a switch for securing different values of plate potential for the electron tubes.

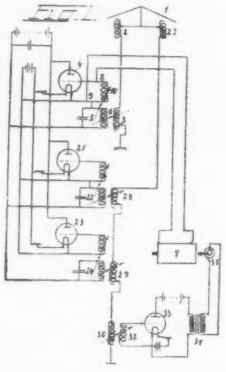
SYSTEM FOR WIRELESS TRANSMISSION OF WRITING, PICTURES, AND THE LIKE

(Patent 1,436,676, issued to Magne Hermod Petersen of Christiania, Norway, Nov. 28, 1922.)

The present invention relates to the systems for transmission of writing, pictures, and the like, in which part of the current circuit of an alternating current generator connected to the transmission leads is short-circuited by means of a contact arrangement, which is so actuated by means of the writing at the sending station that the short circuiting is started or interrupted by means of a contact needle passing over the written lines.

On the drawing is diagrammatically illustrated a form of the invention.

Fig. 1 illustrates a diagram for a sending station and Fig. 2 the diagram for a receiving station.



As in all ordinary radio systems there is used a sender and a receiver. This sender comprises an antenna, 1, with an extension coil, 2, and the secondary winding, 3, of a high frequency transformer. By means of the extension coil, 2, the wave-length of the antenna oscillations is regulated, and by means of the secondary winding of the high frequency transformer, energy is received from the sending apparatuses.

The sending apparatuses comprise a vacuum tube generator, 4, of known construction and effect. This vacuum tube generator generates continuous (undamped) oscillations, the wave-length of which is adapted for the purpose, for instance, 600 m. The wave-length is regulated by means of the oscillating circuit, 5—6, and the oscillations are transformed from the primary winding, 6, of the high frequency transformer to the secondary

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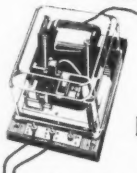

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Klaus Radio Dealers receive expert service in radio problems and in radio merchandising. Our dealers *make more money*. We want a dealer in every city and town. Some territory is still open. Write for our trade discount lists and the "Klaus Radio Bulletin."

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RADIO HEAD SETS

TRIMM PROFESSIONAL Retails for $7.65

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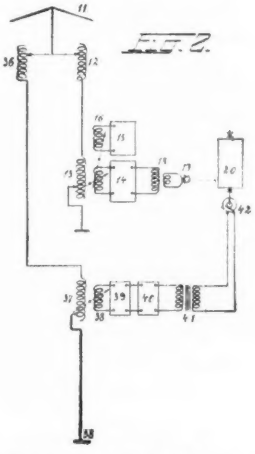
TWO WONDER VALUES

TRIMM RADIO MFG. CO.

Dept. 43, 24-30 S. Clinton St. Chicago, Ill.

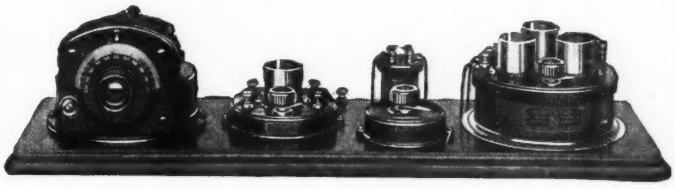
winding, 3, and emanate from the antenna in the form of electro-magnetic waves. 7 is the sending cylinder of the copy telegraph apparatus. The telegram, comprising a picture or writing of any kind, is transferred chemigraphically to the cylinder in such a manner that the lines are electrically insulating. During the rotation of the cylinder a contact needle describes a helical line on the same. When the contact needle touches the metal a contact is formed, and this contact is broken when the needle is passing over a line of the writing or picture. From the contact needle and metal of the sending cylinder, two lines lead to the screen circuit of the vacuum tube gener



ator, and are connected at points, 8, 9, in parallel to the screen coil, 10. It will be understood that when the contact needle on the cylinder is in contact with the same, coil 10 is short circuited, whereby the emanation of waves from the antenna is intercepted, and when the contact needle passes an insulating part of writing, the short circuiting is interrupted, and continuous (undamped) waves emanate from the antenna as in a modern radio station provided with vacuum tube sender. The waves emanated are taken up at the receiving station by the antenna 11 and conducted over the antenna coil 12 to the antenna coil 13 of the receiving transformer, whereupon it is transferred inductively to high frequency intensifying detector

ATWATER KENT

RECEIVING SETS AND PARTS



This is one of several sets made up in various combinations of parts. All sets and parts are described in an illustrated folder.

ATWATER KENT Sets and Parts are ideal for summer use due to their compact and rugged construction and the fact that they are moisture-proof. They are made mostly of condensite and are thoroughly water-proofed.

Send for the illustrated folder

ATWATER KENT MANUFACTURING COMPANY
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Here's good news for the lovers of *REAL* RADIO MUSIC

HERE'S a new Audio Frequency Transformer that, on actual test, has shown that it gives greater amplification and greater fidelity of reproduction over the whole range of orchestral music.

From the slow rhythmic beat of the kettle drums (30 or less cycles per second) to the upper octaves of the piccolo (8000 cycles per second) every instrument in the orchestra and every note played by that instrument is reproduced more strongly, purely, faithfully than you had dreamed possible.

Install one on your present set. The result will be a revelation to you of what radio can mean in your home.

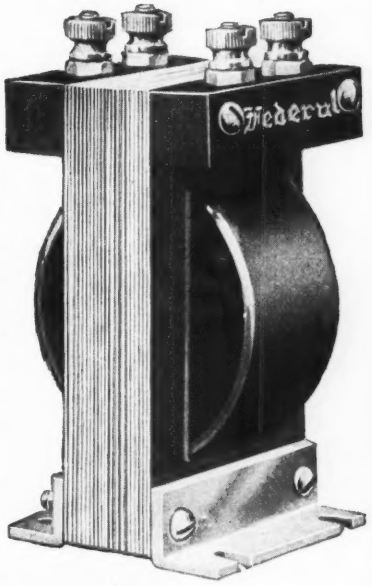
And the same engineering skill, based on twenty-three years' experience in the manufacture of communication apparatus, is behind every Federal Guaranteed Radio Product.

There are now more than 120 separate, individual Radio Products in the complete Federal line.

From head-sets to grid-leaks you will find each Federal product to be the best of its kind. You are *sure* of satisfaction. We *guarantee* it.

Send today for illustrated catalog, describing them fully.

Federal Telephone and Telegraph Company
BUFFALO, N. Y.



Federal Standard
Audio Frequency Transformers
No. 65

CONTINENTAL

"New York's Leading Radio House"

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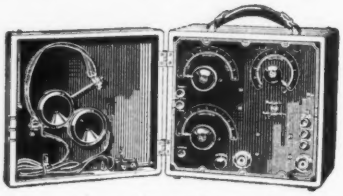
Radiola II

Portable Set for Summer!

PRICE

$97.50



Step into our show room and let us demonstrate to you the Radiola II.

In the woods, on the road, over the water, anywhere—Radiola II never fails to please its listeners

Standard products give standard performance. Radiola II may be installed anywhere at any time, and will bring in programs from far and near.

A few of the characteristics which add greatly to the quality of this set are its strength of construction, simplicity of operation, economy, using UV-199 dry cell tubes, sensitivity and the handsomely finished case, which makes the set self contained.

Dealers! Give the Radiola II a chance to boost your Summer Sales and watch it sell itself. Send your orders in now.

"Modern Radio"—A two hundred and eight page catalog of Radio equipment, supplies and apparatus sent for twenty-five cents.

Distributors for R. C. A. 2038-Q

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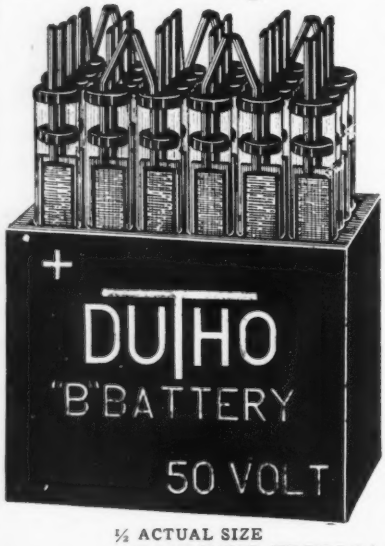

½ ACTUAL SIZE

Build a DUTHO into your set: will not leak, absolutely noiseless, emits no fumes, easily recharged, large capacity, small size, will last indefinitely.

25 Volt $5.00
SIZE 3"x2½"x6"

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Factory—Lynbrook, L. I.
We carry a Complete Line of Radio Apparatus

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COLORADO
9ZAF REYNOLDS RADIO CO. KLZ
1534 Glenarm St.
LARGE RADIO DISTRIBUTORS

and low frequency intensifier of a known type and placed together in apparatus 14. The said high frequency circuits can, however, not be used directly for driving the receiving apparatuses of the copying telegraph. The receiving apparatuses, which can be used, comprise oscillograph receivers, spark receivers and others.

A Low Power Phone and C. W. Transmitter

(*Continued from page* 157)

cypress carefully treated with shellac. Tube cabinet is 10" by 13" by 6" deep.

Unfortunately, both tubes and a generator are expensive, but it is possible to obtain cheaply a used 500-volt shunt wound motor of, say, 1/10 h. p., which, when driven by a suitable motor, gives excellent results. The combination should cost less than twenty dollars.

Correspondence from Readers

(*Continued from page* 161)

If some one should write in saying that he had received programs over a distance of 800 or 1,000 miles, with a simple crystal receiver, what an argument he would start.

And, furthermore, if this same person should declare that he was receiving *ARC* stations on the above mentioned receiver, using two small honeycomb coils which may be purchased for less than one dollar, that would settle his fate. Every radio fan would be in favor of putting him in a padded cell and calling an alienist.

Now that I suggest these three possibilities, some one will ask "Can it be done"? I answer, "It can be done, and is being done right now."

Here's what is puzzling me. "Do experts think these things impossible?" "Do they think, by concealing the facts, to encourage the credulous public to purchase more expensive sets?" "Has no one happened to stumble onto the secrets contained in the simple receiving set?"

KENNETH OVERLY,
Grant, Michigan.

GUILTY STATIONS

Editor, RADIO NEWS:

I wish to make a few comments on the item appearing in the April, 1923, issue of RADIO NEWS entitled "Radiations." I only regret that the real offenders have not seen it, or, having seen it, fail to heed it. Such powerful stations as WSB, WBAP, WFAA, WGM, WEAY and even WOC at Davenport have been guilty of acknowledging telegrams and telephone calls via radio. It is very tiresome and annoying, after having heard a splendid selection, to have the spell broken by a long list of acknowledgments. It perhaps gives the sender of the telegram a degree of satisfaction to hear his name mentioned by such novel means, but it is very provoking to others.

I am sure if we should go to hear a famous orchestra or noted singer some evening, we should be disgusted beyond measure to have someone come out after each number and make an announcement. So is it with radio. True, with radio we can tune out the offending station, but it is very likely that we should tune in another committing the same offense, as this practice seems to be becoming universal. I do not think the offending stations are guilty of any intentional wrong-doing; they merely need to have the matter brought before them. I trust you will have more to say concerning

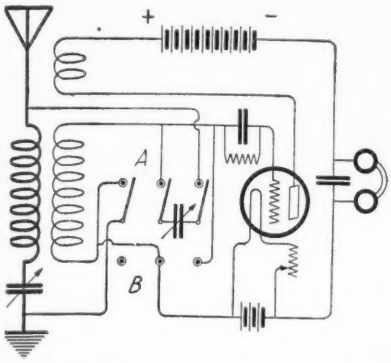
this unlawful practice in later editions of your valued magazine, and probably it will fall into the hands of those who need it most.

H. K. MAYFIELD.
Horse Cave, Ky.

AN IMPROVEMENT

Editor, RADIO NEWS:

I read Mr. J. R. Tonnehill's description on "Reducing Interference" in the March RADIO NEWS. I heartily agree with everything he says, except that it is rather inconvenient with so many switches, so I have enclosed a hook-up which I think is much simpler.



A Simple Switching Arrangement by Means of Which the Receiver Can Be Made a Single or Double Circuit Type.

My first set was a single circuit and I had the same trouble that Mr. Tonnehill had and many others are having. I discarded this and built a honeycomb set, but I missed the single circuit for its simple tuning and loudness, so I employed the accompanying hook-up.

The switch is of an anti-capacity triple-pole type; when thrown up to *A* the regular two-circuit is being used, and when thrown to *B* the primary coil must be pulled out and you then have a single circuit.

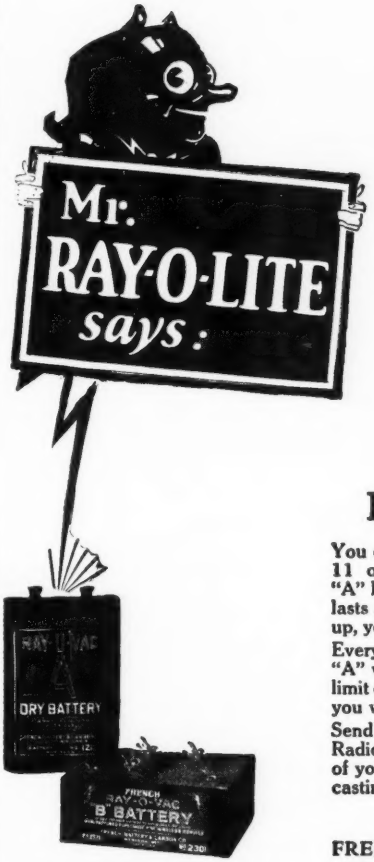
JOHN HOLAPIAN.

MORE FROM NEW ZEALAND

Editor, RADIO NEWS:

I notice in a recent number of your publication an article on DX work by amateurs on 200 meters. I believe it was written from Honolulu and the author gave some long distance reception records. Also in a previous number, a station operator in Samoa accomplished some wonderful reception. Previous to reading these articles I never considered it worth while trying to receive American amateurs in New Zealand, as we were so far away from our cousins. However, when I learned that during the month of May this year tests were to be conducted with Australia by American amateurs, I thought it possible that reception could be accomplished here. The following were copied without H. F., using three steps of A. F. on an aerial erected near a beach over sandy ground. The aerial has an average height of 20′ and is 150′ in length. The earth consisted of a clean kerosene tin filled with water and sunk in dry sand, also fences (wire) as counterpoises.

Saturday, March 17, 1923. 4XJ De 6ZH, 6:35 p. m., N. Z. time (about 19.00 G. M. T.). (CQ de 6ZH) 6ZH heard often, good sigs. 5XB de 6ANH, 7:05 p. m. (QTC hr QSR? 5XB de 6ANH.) 9AIX de 6ANH, very clear and strong sigs. (R. O. K., QTC hr QTC QSV? 9AIX de 6ANH.) Msg hr K No. 1 to T. H. McNeil, 302 East —— Kansas City, Mo.: "Hope u all . . . etc. 5ZA de 6? Did



Use Ray-O Vac "B" Batteries for sustained voltage, longer service and elimination of noise.

Improve Radio Reception

You don't know what *real* radio is 'till you've tried WD-11 or WD-12 Dry Battery Tubes with a Ray-O-Vac "A" Dry Cell. The cost of a single cell is small and it lasts a long time. And say! when you get them set up, you won't know the old set.

Everybody knows that this combination of Ray-O-Vac "A" with dry battery tubes gives clearer signals. The limit of your set is picked up easily and sounds as though you were right in the same room. Units 1, 2, 4, or 6-cell.

Send for the free booklet "How to Get the Most out of Radio," full of interesting things about the use and care of your set. Also gives a complete list of official broadcasting stations with their signals.

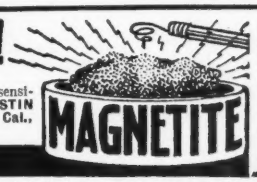
Ask your dealer for this new battery—

FRENCH BATTERY & CARBON COMPANY
Madison Wisconsin
Atlanta Dallas Denver Minneapolis Chicago Kansas City New York

RAY-O-VAC
The Battery that Completes Radio

Hit it anywhere!

MAGNETITE RADIO-CRYSTAL—the **world's** most sensitive and efficient Crystal-Detector. **GIBBONS-DUSTIN RADIO MFG. CO., 518 West 9th St., Los Angeles, Cal., U. S. A.,** owners and national distributors.



Magnetite Radio-Crystal is unaffected by **handling** or **moisture** and will render efficient service indefinitely. Ideal crystal for REFLEX Circuit and R. F. MOUNTED or UNMOUNTED. **Price 50 cents** at all **Dealers**—or mailed direct — **GUARANTEED.**

ELECTRIC SOLDERING IRON

EVERY RADIO FAN has been looking for this iron for both radio and home use. Operates on A. C. or D. C. current.

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GUARANTEED one year. Sent anywhere in U.S. or Canada Parcel Post prepaid on receipt of money order for $2.28.

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Gold Stripe Radio Headsets

No. 500
2200 Ohm
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Absolutely equal or superior to other standard makes at much higher prices

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"I am the owner of a pair of DELTA GOLD STRIPE RADIO HEADSETS, (2200 Ohms.) "I have compared my DELTA Phones with a pair of 3000 Ohm Phones I have and would prefer the DELTA anytime. The DELTA is certainly great."
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Standard Makers of Radio Apparatus, Bicycle Lamps, Auto Spotlights, Lanterns, Flashlights and Flashlight Batteries
NEW YORK SAN FRANCISCO WINNIPEG

A LOUD SPEAKER *and* REPRODUCER IN ONE
BRISTOL AUDIOPHONE

MORE THAN A LOUD SPEAKER the AUDIOPHONE is a real reproducer of the original broadcasting. It is easy to listen to the Audiophone reproduction, because they are so perfect. The speech, songs and instrumental music are not blurred or disguised by mechanical distortion. You get all the fine shadings and every inflection. In fact, the very personality of the artist seems to be present as you listen.

DEVELOPED in the laboratories of an engineering firm known the world over for recording instruments of precision.

COMPLETE in every way and ready to connect to the receiving set.

NO AUXILIARY BATTERIES are required for magnetizing.

ADAPTED for use on all types of two or three stage power amplifiers.

TRADE MARK
AUDIOPHONE
REG. U. S. PAT. OFFICE

THE BRISTOL SINGLE STAGE POWER AMPLIFIER for use with the usual two-stage amplifier can be furnished, which will greatly increase the range of the Audiophone where desirable. Price **$25.00**

Write for Bulletin 3006-S.

MADE IN TWO MODELS:
BRISTOL AUDIOPHONE SR. Loud Speaker. Size of Horn 15-inches Diameter. Price **$32.50**

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not get call letters. QRN. 6CGW ex 6IF CQ QSL de 6CGW, 9:55 p. m. 8BCH de 6CFM. March 18, 1923. 2FP de 8? Did not get call letters. QRN, 6:45 p. m. 6FF De 6OZ, good sigs. Also 6ZZ, very good sigs. March 21, 1923. 1BCG and 3FQ de 8ZT, 10:05 p. m. Also about March 1, 9DOK and 5ADO de 6BFV were also heard.

I think the above performance is much more creditable to American amateurs than crossing the Atlantic. The distance from New Zealand to 8ZT is about 8,000 miles. A marked fading of signals is noticeable and makes reception difficult, but the signals from local stations (spark) also fade, so perhaps it is due to local conditions. It is noticeable that when an amateur is calling he is nearly always readable when he starts up, but fades away when he is signing off. Most of the 6's heard were good and clear.

Amateurs in New Zealand are now coming into their heritage, as regulations are being issued at present for transmission, the power being limited to 50 watts for Grade 1 amateurs. We receive all the big stations of the world here, including England, and who knows before long we New Zealand amateurs may yet get into communication with your amateurs. I should be glad if any of the above amateurs would drop a line, giving me particulars of their power, etc., also type of circuits.

Your magazine is eagerly looked forward to each month, and as far as the amateurs go, it is the authority on radio. The writer has been reading it ever since it started as "Modern Electrics."

IVAN. H. O'MEARA,
Gisborne, New Zealand.

GOOD WORK

Editor, RADIO NEWS:

Being a kid amateur, perhaps I have no business nosing my way into the doings of some of my elders; however, loving the keys of a typewriter almost as well as the brass I will take a wang at it.

Much has been said in regard to the honeycomb inductance. I will state some of my experiences with a standard H. C. hook-up using only one variable condenser and that in shunt with the secondary. With this circuit I have repeatedly heard KDKA, WGY, WWJ, WSB, WBAP, and such near-by stations as Minneapolis, Fargo, Davenport, and Kansas City I hear regularly.

I am able to tune out almost all interferance, and if I had another condenser it no doubt would add greatly to its selectivity.

I have thoroughly enjoyed the letters on "why radio sales fall off." I have had similar troubles myself.

Will some other young amateur please write me?

ALBIN L. SWANSON,
Wheaton, Minn.

Preventing Fraud by Radio

(*Continued from page* 144)

great asset, a two million dollar lawsuit it holds against another company.

Needless to say, the intended investor will keep his money.

Thus the Better Business Bureau has made use of the newest method of communication; literally from the very air, an unsuspecting investor was saved from having his money taken from him.

As Mr. Epsteen stated at the meeting, "If the Mercantile Trust Company had never done anything else with its radio equipment, this one case has more than justified its existence."

proven best filament control

—challenges the world

2000 Miles on 1 Tube with a FIL-KO-STAT

From Paul H. Woodruff
Editor Industrial Power, Chicago.

"I am of the opinion that the Fil-Ko-Stat is the best filament control and have recommended it highly. It is a fact that, I picked up two Los Angeles stations, KHJ and KWH with a single tube regenerative detector shortly after installing it."

Recommended and sold by dealers in high quality radio supplies.

Takes the place of your rheostat! Occupies little space on panel. No redrilling necessary.

Made and guaranteed by

DX INSTRUMENT CO. HARRISBURG PA

PRICE

$2

Proven by every test to surpass any and all rheostats and filament controls, Fil-Ko-Stat rightly challenges the world.

Laboratory research proves Fil-Ko-Stat to have a fine adjustment area (which means ability to control filament heat and electronic flow) eighteen times greater than that of the wire rheostat and several times that of the next best filament control.

Actual use proves Fil-Ko-Stat the most acurate cont ol for any tube from "peanut" to "power." Full resistance 30 ohms.

it has no screws or adjustments to tamper with. It is triple tested and regulated at the factory to the ideal "off" position for

UV 200, 201, 201A, WD11, WD12, UV199, DV6A, W. E. Peanut, etc., etc.

it is non-microphonic, operates noiselessly, eliminating all "frying."

it has no disks to break or chip and its reliability and durability are guaranteed by the manufacturer.

If you have never tried tuning with your filament control, start with a Fil-Ko-Stat. It brings in strong and clear D. X. stations you never heard before.

If your dealer has no Fil-Ko-Stats in stock, send his name and your remittance direct to

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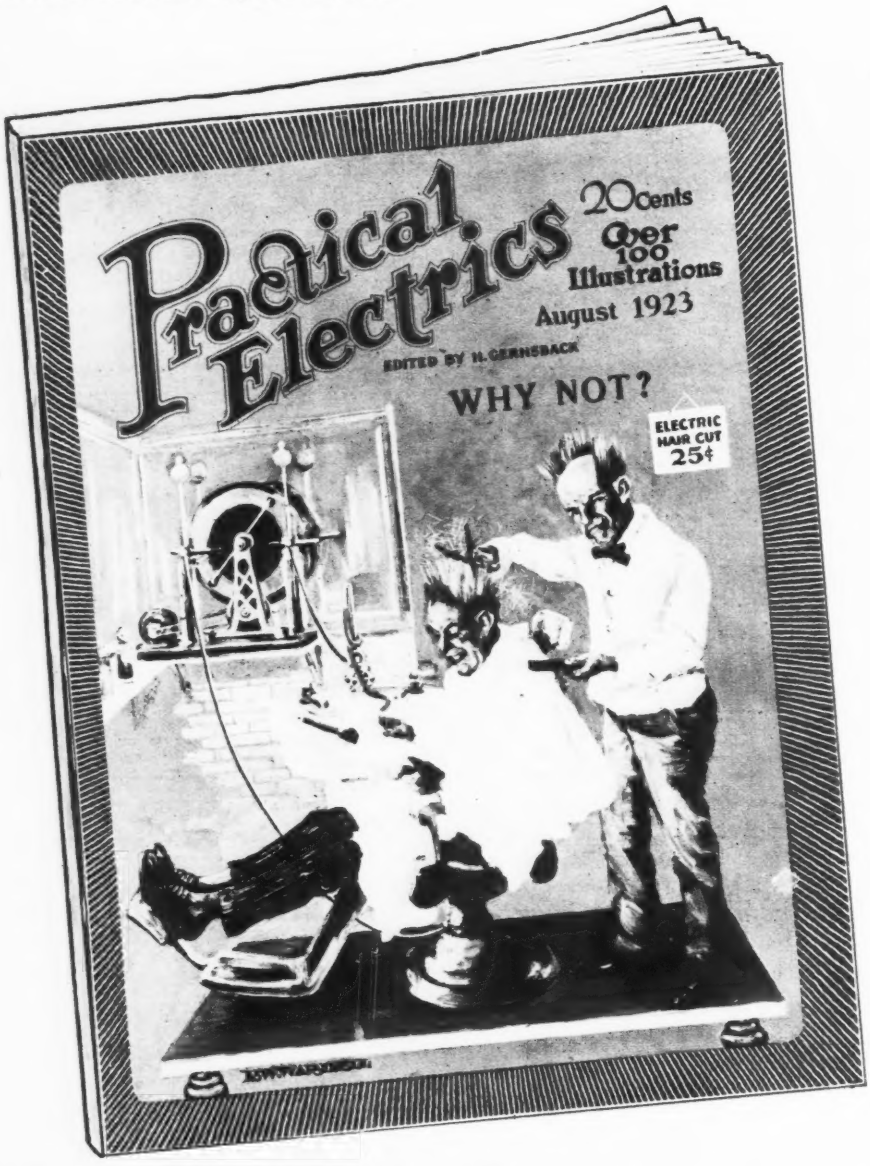
The filament kontrol of infinite adjustment

FIL-KO-STAT

DISTINCTLY DESIGNED TO UTILIZE THE GREAT TUNING POSSIBILITIES OF THE VACUUM TUBE ITSELF.

CIRCULATION 60,000 COPIES



This magazine is edited by
H. GERNSBACK
also Editor of
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and
SCIENCE *and* INVENTION

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The August issue now on the news-stands contains 48 pages and over 100 different articles and over 100 illustrations, with an artistic cover in three colors. Professor T. O'Conor Sloane, Ph.D., is associate editor of the magazine.

INTERESTING ARTICLES IN AUGUST "PRACTICAL ELECTRICS"

New Magnetic Tricks.
Loud Speakers and Movies.
Dry Weather Electrical Storms.
Studying Lightning. By Dr. Albert Neuburger.
Experimental D. C. Transformer. By Amedeo Giolitto.
Cutting Metals With Electric Arc.
Novel Electrophorous. By Dr. Alfred Gradenwitz.
Silver Plated Leyden Jars.
Plante Storage Battery.
Magnetic Gravity Motor.
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$7.00 for the best article on Elec-Tricks, the new department.

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See Current Issue for Full Details.

This issue also contains articles by some of the greatest electrical writers, workers and students. The magazine will prove a revelation to any one interested in electricity.

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Gentlemen:
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R. N. 8-23.

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$6.00 COMPLETE

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The "Rico" TUNED Melotone Speaker

THIS loud speaker is the outcome of several thousand experiments, and we present it to the American radio public in full confidence that we have produced the lowest priced and at the same time the highest class loud speaker on the market today.

The "RICO" TUNED MELOTONE SPEAKER is not a makeshift, not a toy, but a high grade scientific instrument, built in very large quantities in order to give the public the advantage of our low manufacturing costs.

These are the specifications:

Adjustable and tuned "RICO" Loud Talker, fitted in cast metal base, handsomely finished, with two coats of baked enamel;
Nickel-plated and polished gooseneck;
Full fibre horn;
Five-foot attachment cord.

THE TUNED FEATURE

Our cross-section diagram shows our new adjustable feature, by which it is possible to make this loud talker give out almost any sound within reason. The MELOTONE SPEAKER can not possibly shatter nor rattle under any circumstances.

The new development comprises a specially-formed, pure Para Rubber Gasket, accurately made, upon which the diaphragm rests. By tightening or loosening the shell of the receiver its diaphragm approaches or recedes the desired distance toward or away from the pole pieces. So remarkable is this adjustment, and so wonderfully exact does it work, that any sound volume or quality can be readily obtained.

For instance, a given adjustment will bring in certain qualities of sound heretofore unobtainable. It is in your power to TUNE the MELOTONE SPEAKER in such a manner that if you wish a moderate amount of sound you can readily obtain it, or if you wish volume, as, for instance, band concerts, the adjustment can be made instantaneously.

By means of this new adjusting feature, the diaphragm can be moved to or from the pole pieces from .006" to .025". To make the adjustment, simply screw the case within the base of the speaker slightly backward or forward. **No screws, no nuts, no fussing, no damaged diaphragm.**

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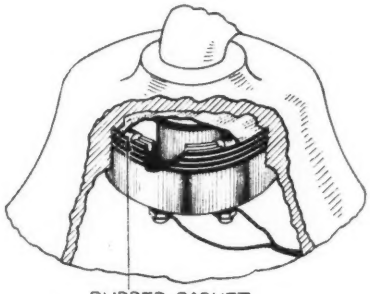
After you have listened to all of the expensive loud talkers, all we request is that you give ours a trial. You will find that it compares favorably with the higher priced loud speakers on the market.

The "RICO" MELOTONE SPEAKER gives quality and volume, without distortion, due to the tuned feature.



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On two or three stages of amplification, any good radio outfit with the "Rico" **Melotone Speaker** will bring in the sounds loud and clear to fill a large room or hall. The fibre horn gives the **mellow tone** that is sought by every radio enthusiast. There is a richness of sound that compares most favorably with the most expensive horns on the market today.

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The dimensions are as follows: Length overall, 14½ inches; Length of horn, 11½ inches; Diameter of bell, 6⅝ inches; Total height of instrument, 9 inches; Diameter of base, 5 13/16 inches; Total net weight, 3 lbs.

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We require no money in advance,—no deposit. All you need to do is to sign the coupon and we will send the MELOTONE Speaker at once, the minute we hear from you.

All MELOTONE Speakers are guaranteed to be as represented by us in this advertisement.

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Each packet contains complete instructions for the construction of these circuits including the tools required, parts needed, directions and pattern for drilling, mounting and wiring and most important of all, full instruction on how to tune the circuit. Sets constructed from these plans have been thoroughly tested and pronounced perfect.

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6. Feed-back Circuit with a loose Coupler.
7. Armstrong Feed-back Circuit.
8. Standard Short Wave Regenerative Set.
9. Honey-comb coil Receiver for all wave lengths.
10. Short Wave Regenerative set, with 2 step amplifier.
11. Combination Circuit for Long and Short Wave.
12. Detector and Two Stage Amplifier with automatic Filament control Jacks.
13. Single Circuit Regenerative Tuner.
14. Circuit for elimination of induction from power lines.
15. Loop Aerial Receiver.
16. Radio and Audion frequency amplifier.
17. Circuit of a C.W. Transmitter for low power.
18. 5-Watt Radio-phone.
19. 10-Watt Phone and C W. Transmitter.
20. High Power C.W. Transmitter

In addition to the above connection diagrams, the packet also includes a four-page instruction pamphlet, explaining each diagram in detail, also, "HOW TO READ DIAGRAMS"—"HOW TO FOLLOW CIRCUITS" and, A COMPLETE KEY OF THE MOST COMMONLY USED RADIO SYMBOLS.

This Packet, Complete with 4 New Supplements

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The Conrad Co INC.

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Formerly the Consolidated Radio Call Book Co.

Detection

(Continued from page 151)

grid, for grid circuit rectification we must use, by some means to be described later, a positive potential on the grid, for the grid current only flows when the grid has a positive potential:

2. Grid circuit rectification requires the use of a so-called "grid condenser and leak," seen in the circuit diagram of Fig. 7, where Cg is the grid condenser and Rg is the grid leak.

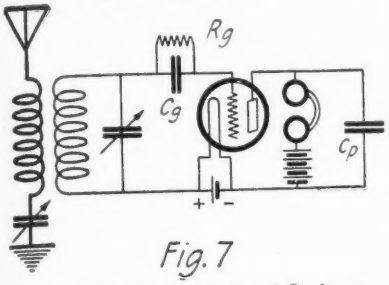
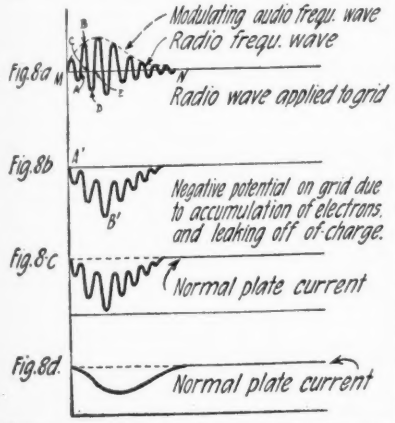


Fig. 7

Receiving Set with Grid Leak and Condenser.

The explanation for the detecting action of the tube when it employs a grid condenser and leak is quite complicated and difficult, but if the reader will pay close attention to the following explanation and follow each point carefully he will obtain a very good idea as to what is happening.

Suppose that we are operating our detector set without the grid leak resistance Rg, and are only using the grid condenser Cg, as in Fig. 9. Fig. 8 (a) represents the incoming radio wave which is part of a modulated radio telephone wave such as might be sent out from a broadcasting station. The individual cycles such as ABCD are the radio frequency cycles, while the cycle designated by the dotted line (which is really the modu-



Showing the Effect and Resultant Plate Current Produced by a Radio Frequency Wave Collected by a Receiving Set of the Vacuum Tube Type

lating frequency) is the audio frequency. Now let us see what occurs when this wave is impressed on the grid. When the upper or positive part of the cycle, namely ABC, is applied to the grid, the grid is charged with a positive potential. As a result there is a flow of electrons to the grid in accordance with the grid current characteristic of Fig. 1. These electrons accumulate on the grid, since the condenser Cg insulates the grid from the rest of the circuit; hence the electrons cannot flow off the grid. Consequently the net result of this flow of electrons to grid is that the grid is left with a negative charge, as all electrons are negative. When the lower or negative half of the cycle, namely CDE, is applied, the grid has a

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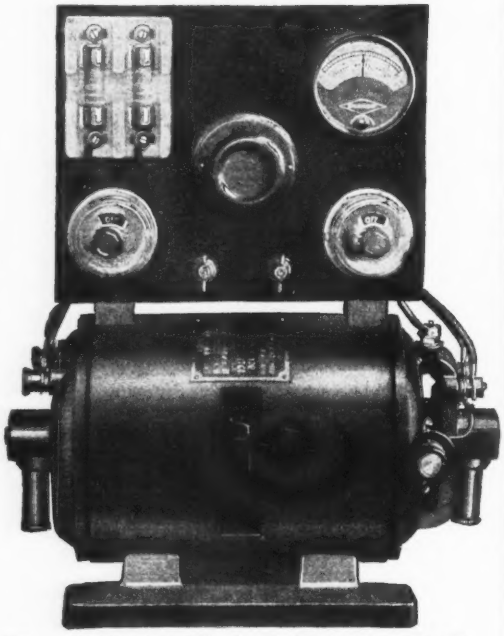

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negative potential impressed on it, and this negative potential simply prevents any more electrons from filament flowing to the grid. As the electrons which are already lodged on the grid cannot leak off in any way, the ultimate result of the first cycle of radio voltage applied to the grid is that the grid is left with a certain negative charge. When the next positive half-cycle of the wave is applied to the grid, there is again a flow of current from filament to grid which electrons are again lodged on the grid and prevented from escaping, due to the fact that the grid is insulated by means of condenser Cg.

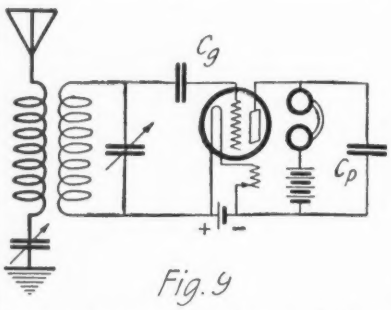

Fig. 9

The Grid Condenser Cg Insulates the Grid from the Rest of the Circuit.

This results in the negative charge on the grid increasing. When the next negative half-cycle of the radio wave is applied to the grid it prevents further flow of electrons from filament to grid, but the negative electrons already on the grid cannot leak off. This process increases until the negative charge on the grid increases to a high value. Now if nothing is done to reduce this negative charge on the grid, the plate current will decrease to extremely low values, as seen from the characteristic curve of Fig. 1, which shows that for high values of negative grid voltage the plate currents are low or zero. This would result in making the detector tube inoperative, which is contrary to our aim.

Suppose now that we connect across the grid condenser Cg a high resistance Rg as in Fig. 7. It will immediately be seen by the reader that the negative electrons which are lodged on the grid by the previous process now have an opportunity to leak off by way of this high resistance, or leak, flowing to the filament. The lower the resistance of this leak the shorter time will it take for this negative charge to leak off. If it is made too low this negative charge may leak off in the time it takes to complete one radio frequency cycle, in which case the grid will always be at the same potential. However, if the resistance is made sufficiently high it will take a longer time for the negative charge on the grid to leak off. By selecting the proper value for the grid leak we can so arrange it that the grid negative charge leaks off in the time in which it takes to complete one audio frequency cycle, as MN. The effect of this would be as shown in Fig. 8 (b). Due to the effect of the electrons flowing to the grid the negative charge on the grid increases as shown by the curve A^1B^1. At B^1 the grid is already charged to its maximum negative potential. However, when this potential has been reached the charge begins to leak off by way of the leak resistance Rg and when the end of the audio cycle is reached, the entire negative charge has leaked off and the grid is again at its original potential.

The above entire process repeats itself all over with the succeeding radio waves. When the grid voltage varies, as shown in Fig. 8 (b), the plate current likewise varies, since according to the plate current characteristic the plate current follows the grid variations. As a result, Fig. 8

(c) shows that the plate current likewise decreases as the grid voltage increases, and as the leak begins to work the plate current rises again to its original value. However, the telephones do not follow the radio frequency variations of the plate current for reasons given at the beginning of the article, but it does follow the mean audio variations in current as shown in Fig. 8 (d). Hence the telephones will respond to this change in current and signal will be recorded. In fact, it is shown by oscillographs that the plate current varies in both a radio frequency manner as in Fig. 8 (c) and in audio frequency manner as in 8 (d). Since the telephones only respond to the audio frequency component arrangements are made whereby the radio frequency current is prevented from flowing through the telephones. This is accomplished by the use of the stopping condenser Cp across the phones, which offers a low reactance to the radio frequency current and thus by-passes it.

Experiment shows that best results are secured when the grid is given an initial positive charge, contrary to the plate rectification method which requires a negative charge. This initial positive charge on the grid serves, as it were, to start the electrons flowing to the grid. The positive charge is generally secured by connecting the grid leads to the positive terminal of the filament battery as in Fig. 7.

The reason that this particular method of detection is so extremely efficient and sensitive is that the amplifying properties of the tube are brought into play. Thus from Fig. 1 we see that for small positive voltages on the grid, where it is usually worked, as at point A, for best detection, the plate currents used are on the straight-line portion of the plate curve. Thus very small changes in grid voltage produce the maximum change in the plate current, resulting in high sensitivity.

Now both of the above methods apply to such radio waves as are sent out by spark or modulated telegraph stations, or the broadcasting stations. For waves which are not modulated by speech or are not interrupted at audible frequencies these means of detection will not apply. For continuous waves other methods must be used, which methods are very important in the radio art. These methods will be described in the next article on detection.

Results of the Radio Shower Party

(*Continued from page* 163)

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The greatest distances I heard on one of your sets is 1900 miles, having heard WGY at Schenectady, N. Y. I think **your set is the best I have ever sold at any price.**
On an aerial 160 feet long and 20 high one of my customers has heard WOC and WHB, KSD, WMC on one of your sets using a Peerless headset.

Herewith P.O.M.O. amt. $1.00 for another "RADIOGEM." The one received is O.K. Placed about 15 ft. of picture cord under front porch and grounded to a gas meter, and heard the Sacramento Bee and Sacramento Broadcasting Union **much better than with my large crystal set.**

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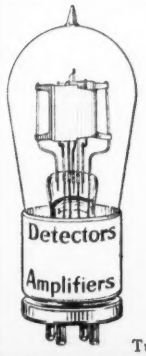
Your two Radiogem sets received last night, and one was wired up for testing. WOC is about 40 miles away, and their signals could be heard with headphones on table. After they quit KYW at Chicago about 170 miles east was heard. Every word could be plainly heard here. WMC at Memphis, Tenn., could also be easily heard and understood.
We find that this set does a great deal more than you claim for it. We took WEAR on our audion set last night; this being the Baltimore American Broadcasting station, and then cut in the Radiogem and got excellent results. After the Baltimore concert was over, we continued to use the audion set and about ten o'clock were listening to WEAF—New York—and a little later we disconnected the audion set entirely and hooked up the Radiogem, very clearly hearing both piano music and announcement of name of station and its location.
You claim a radius of 20 miles over your "Radiogem" is sometimes a possibility. You should adhere to the truth. I constructed one for my mother, installed it with an aerial, and she listens not once in a while, but at her will, to Schenectady, Newark, New York, or Providence, R. I., and her home is Attleboro, Mass. **I can't give your set too much praise.**

(Names and Addresses on Request)



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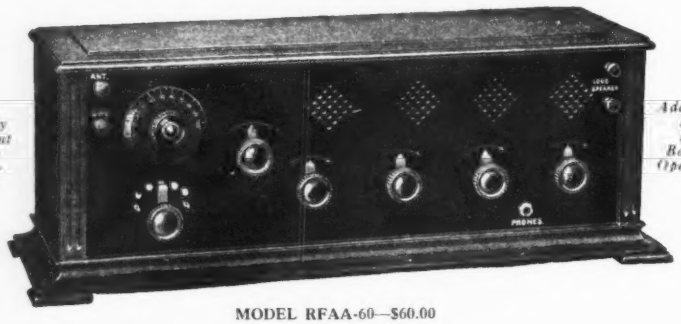

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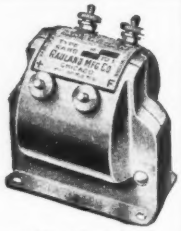

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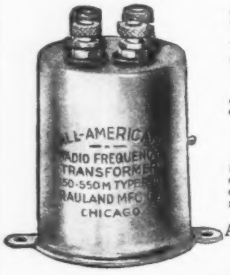

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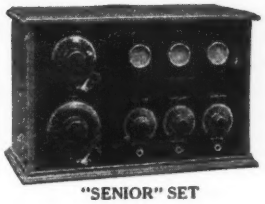

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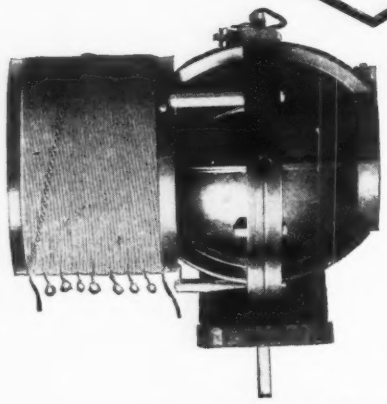

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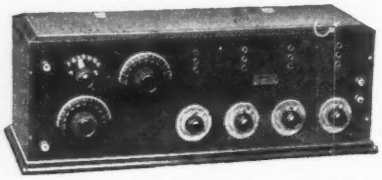

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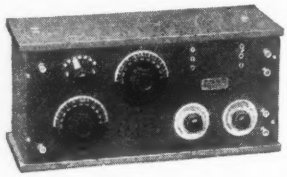

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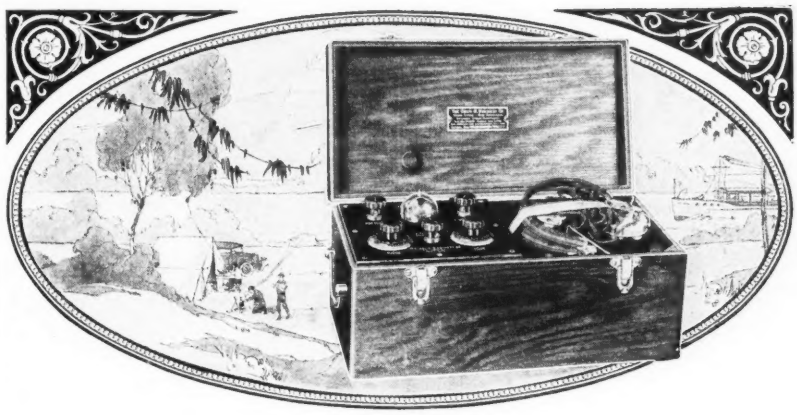

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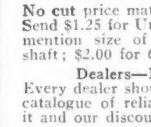

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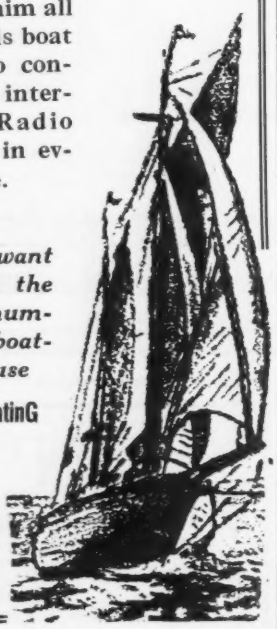

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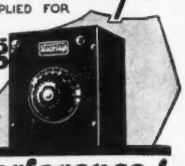

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103. 1 **Murdock Head Set No. 56**—Wm. J. Murdock Co., and 1 **Carter Two-way Plug**—Carter Radio Co.
104. 1 **Double Head Set**—Radio Industries Corp., and 1 **Carter Two-way Plug**—Carter Radio
105. 1 **Membership in The Radio Co-Operative Service Bureau**—The Radio Guild.
106. 1 **Type 231 A General Amplifying Transformer**—General Radio Co.
107. 1 **Fada Variocoupler**—Frank A. D. Andrea.
108. 1 **Large Type "B" Battery**—Hipwell Mfg.
109. 1 **22½-Volt Defelco "B" Battery**—Defelco Battery Co.
110. 1 **WorkRite Variocoupler**—WorkRite Mfg.
111. 1 **WorkRite Variometer**—WorkRite Mfg. Co.
112. 1 **National Airphone Crystal Set Model "G"**—National Airphone Corp., and 1 **W. T. Peanut Tube and Adapter**—Radio Research Guild.
113. 1 **Ricohorn**—Radio Industries Corp., and 1 **Carter Two-way Plug**—Carter Radio Co.
114. 1 **Crystal Set**—Standard Radio & Elec. Co., and 1 **W. T. 501 Peanut Tube and Adapter**—Radio Research Guild.
115. 4 **No. 269 22½-Volt Variable "B" Batteries**—Novo Mfg. Co., Inc.
116. 1 **Set Constructional Drawings of a 10 Tube Super-Heterodyne**—Experimenters Information Service.
117. 1 **Gould Radio "B" Battery**—Gould Storage Battery Co.
118. 1 **Dictograph 3000 Ohm Head Set**—Dictograph Products Corp., and 1 **Carter Two-way Plug**—Carter Radio Co.
119. 1 **Trimm "Professional" 3000 Ohm Head Set**—Trimm Radio Mfg. Co., and 1 **Carter Two-way Plug**—Carter Radio Co.
120. 1 **Loud Speaker**—Standard Metal Mfg. Co., and 1 **Carter Two-way Plug**—Carter Radio
121. 1 **Goodman Wave Tuner**—L. W. Goodman.
122. 1 **Cole Audio Frequency Transformer**—A. B. Cole, Inc.
123. 1 **Frost 3000 Ohm Head Set**—Herbert H. Frost, and 1 **Frost No. 138 Multiple Fone Plug**—Herbert H. Frost.
124. 1 **Murdock Loud Speaker**—Wm. J. Murdock Co., and 1 **Carter Two-way Plug**—Carter Radio Co.
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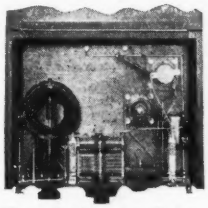
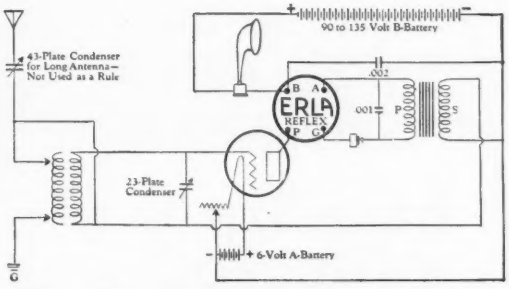
How to Get the Most Out of a Single Tube



Duo-Reflex simplicity assures neat, compact, cabinet installation. Detailed blue prints are on sale by dealers at 25c per set



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Under conditions at all favorable, a wide compass of stations is brought in through a loud speaker, and headphones extend the range from coast to coast.

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Especially designed for Duo-Reflex, and the major essential of its power, is the Erla radio frequency reflex transformer. Synchronizing perfectly the reflected radio and audio frequency impulses, it provides unequaled magnification without distortion.

A complete description of Duo-Reflex, together with directions for its construction, is given in Erla Bulletin No. 13, obtainable gratis from leading radio dealers. Or write us direct, giving your dealer's name.

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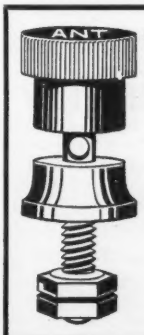

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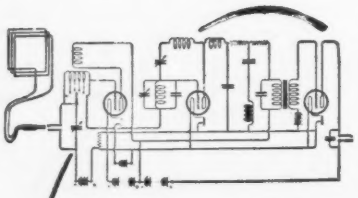

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149. **1 Fada Variocoupler**—Frank A. D. Andrea.
150. **1 Large Type "B" Battery**—Hipwell Mfg.
151. **1 22½-Volt Defelco "B" Battery**—Defelco Battery Corp.
152. **1 WorkRite Variocoupler**—WorkRite Mfg.
153. **1 WorkRite Variometer**—WorkRite Mfg. Co.
154. **1 National Airphone Crystal Set Model "G"**—National Airphone Corp., and **1 W. T. 501 Peanut Tube and Adapter**—Radio Research Guild.
155. **1 Ricohorn**—Radio Industries Corp., and **1 Carter Two-way Plug**—Carter Radio Co.
156. **4 No. 269 22½-Volt Variable "B" Batteries**—Novo Mfg. Co., Inc.
157. **1 Crystal Set**—Standard Radio & Elec. Co., and **1 W. T. 501 Peanut Tube and Adapter**—Radio Research Guild.
158. **1 Set Constructional Drawings of a 10 Tube Super-Heterodyne**—Experimenters Information Service.
159. **1 Gould Radio "B" Battery**—Gould Storage Battery Co.
160. **1 Dictograph 3000 Ohm Head Set**—Dictograph Products Corp., and **1 Carter Two-way Plug**—Carter Radio Co.
161. **1 Trimm "Professional" 3000 Ohm Head Set**—Trimm Radio Mfg. Co., and **1 Carter Two-way Plug**—Carter Radio Co.
162. **1 Loud Speaker**—Standard Metal Mfg. Co., and **1 Carter Two-way Plug**—Carter Radio
163. **1 Goodman Wave Tuner**—L. W. Goodman.
164. **1 Cole Audio Frequency Transformer**—A. B. Cole, Inc.
165. **1 Frost 3000 Ohm Head Set**—Herbert H. Frost, and **1 Frost No. 138 Multiple Fone Plug**—Herbert H. Frost.
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182. **1 Trimm "Professional" 3000 Ohm Head Set**—Trimm Radio Mfg. Co., and **1 Carter Two-way Plug**—Carter Radio Co.
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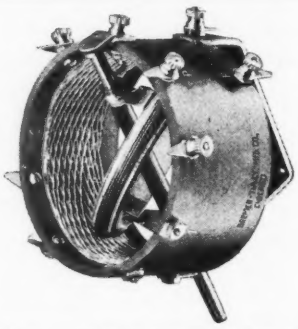

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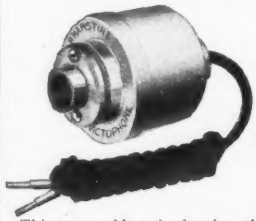

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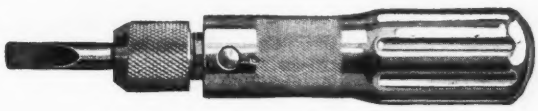
A screw-driver you can carry in your pocket



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LARGE enough to be practical — small enough to carry in your pocket — that's this Goodell-Pratt Screw-Driver.

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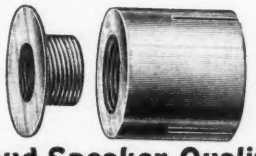

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Including six feet of cord,
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Breast plate,
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Transmitter.

All for $1.00

Sent prepaid upon receipt of Money Order.

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The microphone is of a supersensitive type and is entirely water proof. Remember, it was made for war purposes and only the best of material was used in it.

The microphone has a double swivel arrangement so that any adjustment can be made either to or away from the mouth or side ways, if you want to push it out of the way.

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Or it may be used for land line work inasmuch as it has a wonderfully sensitive microphone.

Due to its peculiar filter plate, this transmitter can be used where there is an unusual amount of noise and still the spoken words will come out clear on the other end.

The entire transmitter is nicely finished and is heavily zinc plated all over. It positively will not rust.

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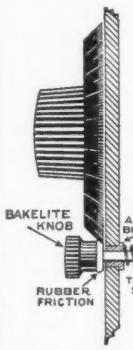

Walnart Vernier Adjuster 25c.

Can be mounted in five minutes. Drill ¼" hole below dial; insert bushing and shaft; push in cotter pin and you can tune-in the elusive far away station.

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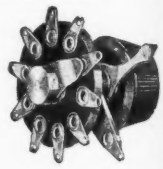

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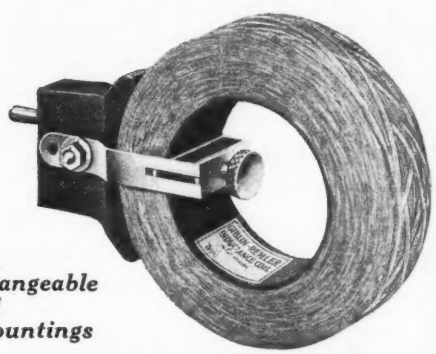

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USE GIBLIN-REMLER COILS

for receiving over the entire range of broadcast wave lengths—

228-546 METERS

THERE are two reasons why Giblin-Remler Coils constitute the very best system of broadcast reception under the new assignment of wave lengths for broadcasting stations ranging from 248 to 546 meters.

First: The coil is so designed as to have maximum inductance, minimum distributed capacity, and minimum high-frequency resistance for a given number of turns. These are the three features most essential to obtain maximum signal strength and maximum selectivity.

Second: It is possible, by the use of the accompanying table, to select a single set of coils for use with condensers of .001 mfd. capacity, that will efficiently cover this entire range of broadcast wave lengths.

Furthermore, the use of Giblin-Remler Coils insures greatest possible flexibility. By merely changing one or more of the coils your set may be made to cover any desired range of wave lengths.

Type and Number of Turns, Mounted	Price, Mounted	Type and Number of Turns, Unmounted	Price, Unmounted	Inductance in Millihenrys at 1000 cycles Accuracy ½ per cent.	Natural Wave Length in Meters, Accuracy ½ per cent.	Distributed Capacity, in micro-micro-farads, Accuracy 1 per cent.	Wave Length Range in Meters using Condenser of .001 max. and .00004 mfd. min. Min.	Max.	High Frequency Resistance in Ohms at Wave Length shown. 200	500	1000	2000
RG 20M	1.50	RG 20U	.70	.030	39	14.3	63	334		1.1		
RG 25M	1.50	RG 25U	.70	.041	47	15.2	75	389		1.5		
RG 35M	1.50	RG 35U	.70	.083	87	25.4	128	550		3.5		
RG 50M	1.60	RG 50U	.80	.169	114	21.6	185	785		8.8	4.4	
RG 75M	1.65	RG 75U	.85	.377	163	19.8	266	1170		28.3	12.1	6.2
RG 100M	1.70	RG 100U	.90	.666	217	19.9	358	1550		80.3	26.8	12.6
									1000	2000	5000	10000
RG 150M	1.75	RG 150U	.95	1.503	281	14.8	512	2320	69.8	23.8	7.1	
RG 200M	1.80	RG 200U	1.00	2.68	374	14.7	690	3110		50.6	12.5	
RG 250M	1.90	RG 250U	1.10	4.20	424	12.1	860	3880		87.5	19.9	
RG 300M	2.00	RG 300U	1.20	6.11	494	11.2	1030	4680		141	29.3	13.8
RG 400M	2.10	RG 400U	1.30	11.04	618	9.7	1380	6300			54.6	22.3
RG 500M	2.30	RG 500U	1.50	17.50	747	9.0	1730	7900			93.1	34.9
									2000	5000	10000	20000
RG 600M	2.40	RG 600U	1.60	29.2	1024	10.1	2260	10250		111	43.8	
RG 750M	2.65	RG 750U	1.85	39.0	1249	11.3	2660	11850			64	
RG1000M	3.40	RG1000U	2.50	71.6	1620	10.3	3570	16000			123	
RG1250M	3.80	RG1250U	2.90	108.0	1930	9.7	4380	19700				
RG1500M	4.40	RG1500U	3.50	159.8	2300	9.3	5300	23800				

These tests have been made by Robert F. Field of Cruft High Tension Electrical Laboratory, Harvard University, Cambridge, Mass.

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RED-HEADS

3000 Ohms

With Military Head-Band and Cord

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22½ Volt Variable "B" Batteries Small	.90
22½ Volt Variable "B" Batteries Large	1.75
45 Volt Variable "B" Batteries	2.50
Eveready Variable "B" Batteries No. 763 22½ V.	1.25
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43 Plate Variable Condensers	1.95
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Look for the Gould advertisement in the September issue.

Gould Radio "A" Battery. Used by the various Radio Branches of the U. S. Government. 60 A.H. to 160 A.H. $18.00 to $33.00 f.o.b. factory.

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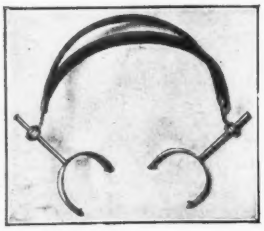

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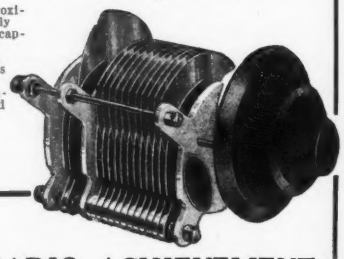

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11 plate DEMCAL variable condenser	3.50
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23 plate DEMCAL variable condenser	5.00
23 plate DEMCAL variable vernier condenser	8.00
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24th R S. Colvin, Fort Story, Cape Henry, Va.
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27th W. F. Kendall, 238 N. Third St., Harrisburg, Pa.
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34th Miss A. E. Price, 5 Vincent Pl., Montclair, N. J.
35th C. W. Herr, 703 Liberty St., Franklin, Pa.
36th N. W. Hill, Huntingdon, Pa.
37th W. B. Harrison, Jr., Miller School, Va.
38th W. L. Eikenberry, 204 Analomink St., E. Stroudsburg, Pa.
39th J. M. Thorne, 54 E. Market St., York, Pa.
40th H. E. Hobbs, R.F.D. No. 2, Chevy Chase, Linden, Md.
41st G. A. Gale, Walsey Farm, Queenstown, Md.
42nd E. D. Zook, Millcreek, Pa.
43rd A. E. Grieshaler, Urbanna, Va.
44th W. C. Smith, 6314 H. St., Philadelphia, Pa.
45th G. B. FitzGerald, 16 E. Locust St., Mechanicsburg, Pa.
46th A. Norden, Jr., 25 S. Ashmead Pl., Germantown, Philadelphia, Pa.
47th H. M. Collins, Box 216, Mt. Troy Rd., Millvale, Pa.
48th H. H. Leh, 32 Green St., Nazareth, Pa.
49th H. K. Ellis, 518 Washington Ave., Phoenixville, Pa.
50th C. P. McCabe, Box 394, 426 Schenck Ave., Butler, Pa.
51st J. B. Bell, Torrance, Westm'd Co., Pa.
52nd G. W. Korman, Osceola Mills, Pa.
53rd A. L. Larrick, 318 N. Main St., Winchester, Va.
54th E. W. Chappell, Bank St., Urbanna, Va.
55th J. M. Bridges, 248 S. Hanover St., Carlisle, Pa.
56th A. W. Sheasley, War Vets Hospital, Mont Alto, Pa.
57th F. Dahlin, West Moshannon, Pa.
58th M. F. Walters, R.F.D. No. 2, Box 14A, Middleburg, Pa.
59th C. Herrick, Shinglehouse, Pa.
60th E. R. Rhodes, Luray, Va.

ZONE 4

1st G. Anderson, 403 Jefferson St., Port Clinton, O.
2nd P. Rinkes, R.R. No. 2, Box 8½, St. Clairsville, O.
3rd J. H. Brumbaugh, 1612 Lake Ave., Wilmette, Ill.
4th B. Millen, 203 High St., Lebanon, Ky.
5th D. F. Starr, Box 15, Sinclair Ave., Steubenville, O.
6th E. M. Wise, 330 Victoria Pl., Toledo, O.
7th H. G. Simmons, 217 Kingston Rd., Kokomo, Ind.
8th Norman C. Hurd, 188 Rob Roy Ave., Fort Thomas, Ky.
9th J. M. Fowle, 2520 Scottwood Ave., Toledo, Ohio.
10th J. E. Wilson, 506 Shelby St., Frankfort, Ky.
11th C. C. Beacham, Chesterville, O.
12th W. A. Triplett, Montgomery Motor Co., 12 E. High, Mt. Sterling, Ky.
13th C. Coleman, 308 Alta Ave., Danville, Ky.
14th H. C. Clark, The Athens Electric Co., 29 S. Court St., Athens, O.
15th A. Owen, 2556 Scottwood Ave., Toledo, O.
16th G. T. Bucy, R.F.D. No. 3, Newark, O.
17th C. A. Gasser, Amer. Tel. and Tel. Co., Maumee, O.
18th C. M. Hauser, 360 White St., Toledo, O.
19th J. J. Stosick, 729 Montana Ave., S. Milwaukee, Wis.
20th W. J. Baker, Route 14, Dayton, O.
21st R. Earhart, 2722 Hampshire Rd., Cleveland, Ohio.
22nd H. Gettles, Wellston, O.
23rd M. De Ford, Box 32, Toboso, O.
24th F. Adcock, 116 W. Hickman St., Winchester, Ky.

ZONE 5

1st K. Richardson, Box 1013, Ft. Lauderdale, Fla.
2nd J. T. Foy, Clemson College, S. C.
3rd F. V. Long, Radio 41H, Bocaratone, Fla.
4th W. F. Rose, 507 Alabama Ave., Birmingham, Ala.
5th B. F. Robertson, Clemson College, S. C.
6th Mrs. H. G. Utley, 407 W. Second Ave., Gastonia, N. C.
7th J. W. Robertson, Tuscaloosa, Ala.
8th H. G. Eliot, 27 E. 4th St., Atlanta, Ga.
9th F. L. Northrop, Tarpon Springs, Fla.
10th H. D. Kennedy, 28 Stockton St., Jacksonville, Fla.
11th W. Moore, care Austin Motor Co., Tuscaloosa, Ala.
12th N. S. Foy, Clemson College, S. C.
13th W. Garrard, 1430 N. 12th Ave., Birmingham, Ala.
14th D. M. May, 112 N. Everett St., Bennettsville, S. C.
15th A. L. Humphrey, Box 1273, Wilmington, N. C.
16th H. E. Richardson, 316 35th St., N. E., Miami, Fla.

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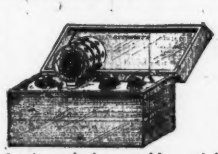

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This complete set, consisting of detector and two-stage amplifier is entirely portable, weighing only seven pounds, and requires no storage battery. It uses UV 199 tubes, and flashlight battery for filament. It can be carried anywhere, and has a range of up to 3,000 miles. Get our complete catalog.

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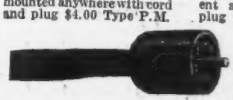
Put this type on your new set it is small and may be mounted anywhere with cord and plug $4.00 Type P.M.

Put this type on seven binding posts of your present set. With cord and plug $5.00 Type B.P.



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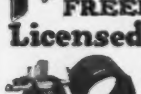

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2nd Gary Flowers, Wynne, Ark.

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4th J. E. Caughey, Wallaceburg, Ont., Can.
5th R. A. Brown, 310 Rubidge St., Peterboro, Ont., Can.
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7th R. Hills, P. B. 375, Truro, N. S., Can.
8th J. A. Kemp, 20 Laviolette Ave., Three Rivers, Que., Can.
9th H. Fairbourn, Can. Pac. Ry. Co., Brockville, Ont., Can.
10th W. J. Thomson, 157 Church St., Brockville, Ont., Can.
11th L. F. Knight, Box 438, Prescott, Ont., Can.
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50th H. R. Ryckman, 517 Nelson St., London, Ont., Can.
51st G. A. Sandoz, Emscote Cottage, Francklyn St., Halifax, N. S., Can.
52nd A. E. Goyo, 313 Monmouth Rd., Town of Mount Royal, Montreal, Can.
53rd Bert MacLeod, R. R. No. 2, Cornwall, Ont., Can.

A New Use for Loud Speakers

(*Continued from page* 133)

Eight transmitters were supplied with the system, usable at any point in the big setting. By means of a control switch in the switchboard house, the director can be connected to any point at once. In the control room is a monitor horn, by which the operator can instantly detect the condition of the apparatus, and 12 Western Electric 6A horns, connectable in multiple, are distributed at the important points. These are specially designed for this type of work. Three are in multiple over the big replica of Notre Dame Cathedral, the rest in and about the old buildings on the Paris streets reproduced in the setting.

Seven circuits lead off the volume control switchboard for the 12 horns and any number may be connected for any special needs. In the control house is a potentiometer control ranging over 24 points to regulate distance of carrying. Each reproducer has in addition a rheostat control.

The volume indicator in the control house is an innovation in this type of system. It operates on a new principle, and is in effect a galvanometer showing 15 points on proper regulation.

A field telephone set enables the director on the scenes to talk back to the switchboard in case of any derangement of the apparatus.

The first three steps of amplification are single, and the fourth or final is a "Push-Pull" arrangement—in effect power amplification.

Radio messages can be received by use of a Radio Receiver, and amplified over the board and broadcast in the same manner as the director's messages are transmitted. A loop antenna is used for this.

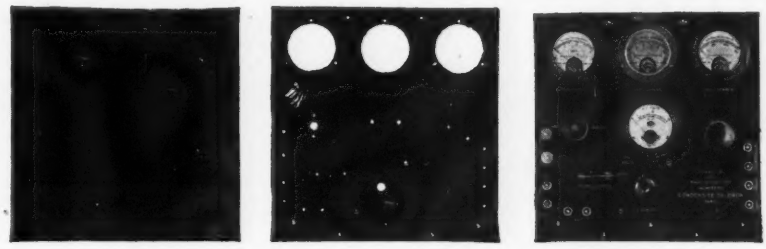
The uses of the set on the picture lot are manifold. Most important, of course, is the work of directing the mob scenes, one director in the tower overlooking the action being able instantly to direct any part of the crowd. It is also used similarly for paging players on the big lot.

The "inspirational music," a valued adjunct to acting for films, is also broadcast for the crowds of players over the apparatus. In fact, the set has made possible for the first time in film history the use of music for mob scenes. Radio concerts between waits are given the crowds of actors, too, thus strengthening morale and creating an esprit de corps that alone has saved a small fortune in the big picture, according to Wallace Worsley, director, and Lon Chaney, star of the production.

Recent Developments In Radio

(*Continued from page* 141)

Dr. de Forest had used his invention for a few years only, when it was found that if this tube were reversed it could be used for transmitting purposes, instead of for receiving. In other words, the Vacuum Tube can be made to send out powerful radio



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The United States Navy Department, the Signal Corps, and the leading Radio Manufacturers, without exception, have adopted our material in one form or another.

They use it because it's a standardized product of uniform quality, and because it is ideally adapted to the manufacture of radio apparatus.

In Laminated form its surface and volume resistivity are extremely high and the dielectric losses quite low as shown by the following Bureau of Standards Tests:

PROPERTIES	HARD RUBBER	LAMINATED PHENOLIC INSULATING MATERIALS
Dielectric strength, volts / mm	10,000 to 38,000	27,000 to 45,000
Tensile strength, lbs. per square inch	3,500 to 6,500	10,000 to 25,000
Water absorbed in twenty-four hours immersion, percentage of weight	0.02	0.2 to 1.0
Thermal expansivity at 20 to 60 degrees Centigrade	60 to 80 x 106	20 to 30 x 106
Heat	At 65.5C. (150F.) hard rubber softens perceptibly; at 100C. (212F.) it is so soft it may be bent easily; at 115.5C. (240F.) it becomes leathery and may easily be cut with a knife; melts at 200C. (392F.)	Not readily inflammable; will withstand continuously temperature of 149C. (300F.) Heat tends to complete reaction and volatile substances are driven off.
Sunlight	Discolors and disintegrates after a few months; the sulphur of the hard rubber is oxidized, forming the equivalent of sulphuric acid; this may take up ammonia from the air or may attack the filling materials forming the various sulphates on the surface; the surface resistivity is greatly reduced.	No visible effect.

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2000 Ohm Murdock No. 56 Head Sets	3.75
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My W. D. 11 Circuit is especially designed for use with the "Pickle" tube and brings out the full value of that little tube as no other circuit can. Stations 1000 miles away come in clearly on one tube. This set is small, complete, portable. For the man who wishes the highest efficiency this is the set to build. Price of blueprint and specifications 50c, or with complete and perfect windings $3.00. Photo of set with every order.

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S. A. Twitchell, 1927 Western Ave., Minneapolis, Minn.

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October 6, 1914
Write for Bulletin No. 7
CHELSEA RADIO COMPANY, CHELSEA, MASS.

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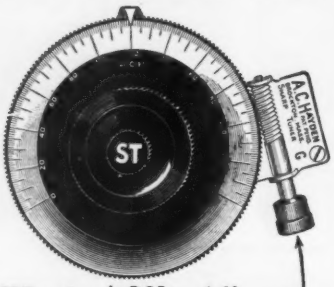

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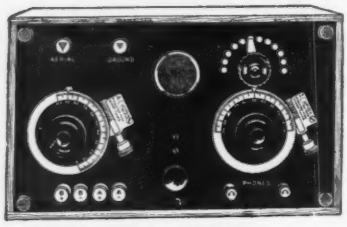

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waves as well as receive waves. The transmitting tube, therefore, takes the place of the old Marconi Spark Gap, and the more recent Alexanderson Generators. Indeed a tube recently constructed by one of our great electrical companies handles over 1,000,000 Watts, and does not take up much more space than an ordinary desk drawer. But this tube can handle sufficient energy to throw radio waves across continents and oceans. Already our big trans-Atlantic stations, which comprise many acres of ground to house their machinery, are doomed on account of this new monster tube. The future radio station power plant will be located in a small room less than 10 feet square, instead of so many acres. And, best of all, a Vacuum Tube handles the energy with much greater economy than the Generators did before.

The versatility of this tube, which has often been called "Aladdin's Lamp" quite appropriately, does not stop here. For instance, when a man in New York picks up his telephone receiver and asks for a friend in San Francisco, he little realizes that he could not do so at all were it not for the Vacuum Tube. Without this it would be impossible to speak over such great distances. Only the perfection of the Vacuum Tube makes the long distance wire telephone possible.

You would not think it possible to measure 2/1,000,000 of an inch. This, however, can be done readily by means of the Ultramicrometer, an instrument that would not have been in existence without the use of the Vacuum Tube.

Imagine a bar of steel, 10" long, and ½" thick. If a fly hops upon this rod, the small weight of the fly will depress this heavy rod a sufficient amount so that it can be measured on the Ultramicrometer—a thing almost impossible to conceive, but true, nevertheless.

In the latter part of 1922, the War Department sent a radio message to an airplane aloft, and this message came out in the form of a tape with the words typed upon it in plain English. In other words, the order was given by radio and the message was typed in intelligible words, in ordinary characters that everyone could understand. The operator made his reply likewise, from the airplane, and the message was received in the War Department on a printed strip, in the English language. All of this has been accomplished thanks to the wonderful Vacuum Tube.

We do not stop here, however. John Hays Hammond, Jr., has repeatedly demonstrated that he can control an airplane from the ground entirely by radio, without the necessity of having an operator aboard. In other words, it is possible today to send a radio-controlled airplane over the enemy's lines or fortifications, and drop bombs at will. All of this can be directed by radio from the ground, at a distance. Again the Vacuum Tube makes this possible.

Recently the Navy Department sent out a battleship on which there was not a human being aboard. Impossible as it seems, the battleship was entirely controlled by radio, from shore, and it was not possible for the maneuvering "enemy" ships to stop the operation of this radio-controlled vessel. All the controls were made by radio. Thus the ship was steered, made to go in a circle, reversed and run backwards. The oil fuel was fed into the furnaces by means of radio control, and there was not a time when the huge monster was not in full control by its distant operator.

There is no question but that in the future we shall have such radio-controlled monsters and their uses are not entirely confined to the sea, because the United States Army has already experimented with radio-controlled tanks, which can be sent out into the enemy's lines without a human being on board to guide them. Again it is the frail little

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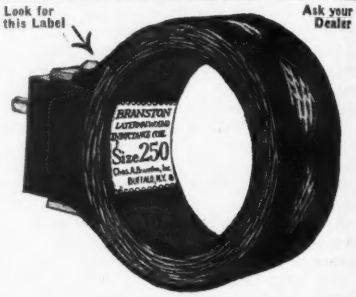

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Vacuum Tube that does the work, as without its use there would not be any radio-controlled airplane, battleship, or tank.

During the war the Vacuum Tube had its fire baptism, and some of the greatest inventions in radio really were made during that time.

Before the war we used aerials, generally; that is, overhead wires, in order to receive radio messages. During the war, the so-called "Loop, or Indoor Aerial" was developed to a wonderful degree. Although the Loop, which is nothing but a wire wound on a square frame, was known before the war, it was never used much. At that time, when it was not possible to use aerials, the loop aerial came into use more and more, and it is now only a question of time when all outdoor aerials will disappear.

The great advantage of the loop type or indoor aerial is that it has directional qualities. By this is meant that if you have a loop receiver and Chicago is broadcasting a concert, you turn the loop so that its edge, or narrow side, points toward Chicago. You will then receive the music or entertainment with maximum intensity.

This quality is made use of in the Radio Compass. When the captain of a ship, nowadays wishes to know what his position is at sea, he does not make any lengthy calculations, as he used to do of yore. He picks up his telephone and calls down to "Sparks," the Radio Operator on board the ship. and utters these few laconic words: "What is our position?" Immediately "Sparks" gets in touch with the nearest land station. There are usually two such stations which receive the call. The distance between these two land stations is known exactly to the land operators. By means of well-known triangulation methods, the position of the ship is ascertained accurately within a few yards, in less than three minutes from the time the call comes in from the distant ship. The land operator of the compass station then radios back to the ship and gives the ship its exact location, exact within a few yards, as mentioned above. In other words, a captain nowadays, if he is in a fog, or during the night, when he has no means for direct observation, can, within a few minutes, ascertain the exact position of his ship. This is not a theory or a dream, because it now happens several hundred times each and every day, all over the world.

Another surprising development of radio is sending pictures from a distance. This is not a new invention either, as it has been known for the last 15 years, but the use of the Vacuum Tube has made the invention commercially practical, and it is not uncommon these days to have pictures sent from France to America by radio, within a few minutes. The Frenchman, Belin, who has made a specialty of such picture-transmission, has achieved remarkable results. The principle is quite simple: Each station, either receiving or sending, has a revolving cylinder upon which the picture, properly prepared, is wrapped. A stylus then travels over the picture, making contacts on certain parts, and these contacts are translated into radio waves, and are shot out to any distance required. At the other end a similar stylus actuates upon a cylinder, and in a few minutes the picture has been assembled, and can then be reproduced by the regular process. Thus it is possible today, by means of such a machine, to radio important photographs or pictures across land and sea in the short space of a few minutes.

Another surprising new use for radio has been found recently in mining. By means of radio waves it is now possible to accurately locate ore or coal deposits. The principle is simple: Radio waves pass through solid substances as easily as light passes through a solid glass block. As long as we have only plain earth or sand, the radio waves travel through such strata without much difficulty. If. however. the waves

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Hetterby's Set

(*Continued from page* 136)

Jessica cried, "Come on, Sam, we'll go right down to the electric shop and get what you need this very minute, and I'll help you wind the wire and everything, and we'll be hearing a really truly radio program before we have to put the cat out and lock up the house for the night!"

So she went away laughing, dragging Sam by the arm and making him hurry. They turned down toward the main street and that was the last we saw of her for almost a week. Then we happened to meet her on the street one day and mother asked her how she liked the radio.

"Well, we haven't got it quite ready to work yet," she said a little soberly. "Sam decided he'd have one a little better than yours. When we went down to the electric shop he saw a—a something or other; I don't know whether it was what he calls a grid-leak or a vernier or what; maybe it was a different sized wave-length—and the electric shop man explained a different way to make a radio set, so Sam is making that kind. It takes a little longer, but Sam says it will be ever so much better."

After that we used to see Jessica every now and then and we always asked how the radio set was getting along, but it was never quite ready to use. She was just as cheerful and hopeful as ever, and just as sure Sam would have the set ready to use in a day or two, but Sam was always discovering something new and better to put in his set, and then he had to tear the set all apart and begin over again. One week he would discover a new quick-acting vernier rheostat or a new style tubular grid-leak and he would junk everything and begin again, and the next week he would hear of a new filament bulb that was built like a link of bologna sausage, with terminals at each end, and he would decide not to have a crystal set but a tube set, and he would junk everything and begin again. Or he would hear of somebody's brand new pretzel-curve spider-web winding and throw away all his variometers and vario-couplers, and start in on a new set. He was always just about ready to go ahead and finish the set and put up his aerial, but ten minutes later he would hear of a new sort of something or other or a new kind of circuit somebody in New Zealand or Timbuctoo had invented, and he would junk everything and begin again.

About a year and a half after Jessica and Sam had first come to our house to see father's radio, Jessica's first baby was born—a fine eight-pound boy. For the first week Sam called the boy Steinmetz Hetterby; the second week he called him DeForest Hetterby; the third week he called him Atwater Kent Hetterby. And I believe that boy never did get an actual hold-fast name until he was twenty-one and chose one for himself—we all called him "Bub" up to the time he was twenty-one, because Sam was everlastingly getting interested in some new radio appliance and naming the boy after its inventor. There was one awful week during which the boy hid in the attic and wept day and night because his father had decided his name was to be Modulated High-Frequency Electromagnetic Voltage Het-

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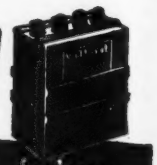

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terby. But if the boy had been older and wiser he would not have wept over that, because he might have known his father would rechristen him plain KDKA Hetterby the next week. The boy, when he was twenty-one, took the name John Hetterby; he told us he had had all the fancy names he could stand and wanted something plain and common for a change.

John was as fine a lad as I ever knew and when he was eighteen and graduated from High School he went immediately into a grocery store as a delivery boy, and by the time he was twenty-one he had worked up to a clerkship, and the family was able to live pretty well on what he earned, although there were six other children by that time. Sam Hetterby had, of course, given up his job in town. When he was not busy junking a radio set he had about completed, or beginning a new one of which he had just heard the details, he was busy all day before the blackboard he had rigged up, drawing spirals that meant one thing and wiggles inside a circle that meant another, trying to work out improvements on a new Flewelling circuit, or on a new three-tube reflex circuit, or on a Colpits oscillator circuit. Every time he had a new and better system worked out on the blackboard, he would put another mortgage on the house and buy a hundred and sixty new parts and set to work, but when he had worked three days at it, he would pause with a screw driven half way into something or other and turn and look at his blackboard and jump up and begin erasing a symbol here and a jigjag there, and presently he would have eight magazines and a new box of white chalk and he would be all tied up in a new and better hook-up that would be a world-beater if he ever got it figured out.

My father lived to be a fine old man with white whiskers, and he died happily with a pair of ear-phones on his ears, listening to a church service that seemed to hold a lot of comfort for him, and for years his only expense had been a little battery renewal and a new ten cent crystal now and then, but poor dear Jessica Hetterby would not come in and listen to our radio.

"No," she used to say, "Sam wouldn't like it. Sam's got his almost ready now—he's only got another day's work on it—and then, if the .006 mfd. condenser comes from that firm in Hong Kong, I'll be hearing our own set, and that will be so nice! I can't tell you how I have longed and longed to hear a real good radio program, but I'll be hearing one in a couple of days now at the most. I'll be so happy!" And then she would tell my sister that the dentist said her new false teeth would never be noticed at all, and ask my sister where was the best place to buy a switch of false hair —gray hair.

I remember that it was the day the doctor advised me to give up golf because my arteries were hardening—nothing serious, you understand; merely a usual result of old age—that Jessica came over to our house, leaning on her cane, and said she hoped to invite us over the next night to hear Sam's set.

"He has just rebuilt it completely," she said—she mumbled a little, having no teeth at all now—cheerfully, "and he says the alternating kick-back circuit he is using is going to be wonderful. All he is waiting for is the new Awkawhak gasgometer he ordered from the Eskimo Radio Supply Company at Rajavik. There's a wonderful program tomorrow night; you *will* come over, won't you?"

She was so eager and it was all so pitiful that we said we would, but it was a year later before we ever did go to Jessica's house. Little Roger, her eldest great-grandchild, came over to our house and said his great-grandma wanted us to go over, please, because great-grandpa Hetterby was just

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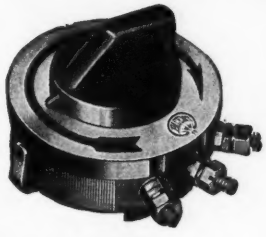

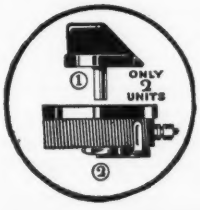

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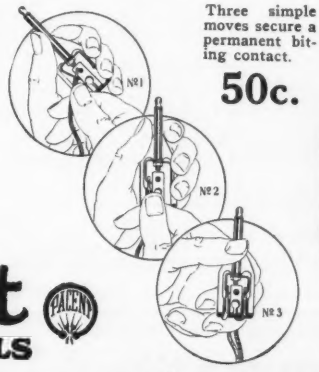

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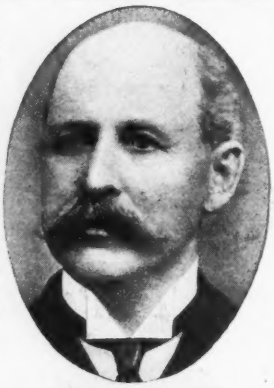

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going to complete his radio set and she wanted us to be there and hear it.

"She says please come right away, because she don't feel very well and she thinks you'd better come soon."

I must say that, as she lay there in her bed, she was very good looking for a woman of ninety-five. Weak and feeble she was, of course, but eagerness had given her a high color, and they had propped her up on her pillow. She was all in lacy bed garments, with a lace cap that covered her sparse and snow-white hair, and John, her elderly son, sat on a chair at the bedside, holding the dear old lady's hand. She did look so sweet and fond and trustful as she looked at old Sam, who was tinkering with his set in the corner of the room. A pair of ear phones were already on Jessica's ears, ready to be hooked onto the set the moment Sam said the word. Out of the window we could see the aerial stretching to a pole at the far side of the yard. I raised my eyebrows questioningly, looking at John.

"No," he said, "it is nothing serious. She's not sick. The doctor advised her to go to bed, but he says she will spruce up and be herself again and good for another ten years once she hears father's radio. It's the waiting—the long and patient waiting—that has worn her down. But it is all right now."

"Are you sure?" I asked.

"Yes," John said, "I'm sure. This time father will surely complete the set he is working on. It cannot be otherwise. There is nothing left for him to change to. He has tried every style of battery, and every style of home charger, and every mounting of crystals, and every kind of tube. He has used every kind of battery clip, wire-connecting clip, base switch, filament control rheostat, potentiometer, rheostat, condenser and grid leak. He has used every circuit ever invented or discovered, and every improvement on them. He has tried everything that has been patented and everything that has not been patented. He has used every possible combination. He has used every kind of detector. He has used everything and he has tried everything. There is nothing he can imagine that is different from what he has tried, and he is satisfied that the set he is building now is the best possible set that can be made. "Father," he said to Sam, "how long before you will be done?"

The old man—he was almost one hundred years old, but remarkably spry for his years—looked up and put one hand behind an ear.

"Hey?" he queried in his aged squeaky voice.

"How long before you will be done? How long before we can begin to hear something over your radio?" John shouted.

"Ten minutes," the old man squeaked. He turned to his set and began adjusting wires. "Don't be so blamed impatient! You got to give a man a little time; I don't want any of these cheap, one-horse sets, like the kind yon old man's father had."

Poor old Jessica removed her ear phones.

"What does he say?" she cried with alarm. "He doesn't say he's going to start in and make a new set, does he?"

"No, Mother; no!" John assured her. "He won't do that now. There is none he has not tried. Be comforted, Mother, dear. He says the set will be ready in ten minutes."

"Ten years? Did he say ten years?" she cried with fright, for she had had quite full experience of the radio fan who never more than gets a set ready to use than he tears it apart to make another.

"Ten minutes," John said. "Not ten years; only ten minutes, Mother dear, and then you will hear a real radio program. Don't be impatient, dear Mother; Father is working as fast as he can now. Just be calm and take things as easily as you can. Here, I'll read you the program."

So he began, holding his mother's poor

thin hand, and read her the program—Russian dance from Moscow; banquet, with speeches, to the President of the United States of Asia at Canton; chorus by the trained soprano kangaroos broadcasted from Australia; ten minute sermon by Rev. Jukes, missionary to Central Africa; bird chorus by the chulu birds of South America, broadcast from the headwaters of the Amazon; ragtime from Ridgewood.

Tears of joy ran down Jessica Hetterby's furrowed old cheeks as her gray haired son read these words and at that moment old Sam Hetterby straightened his bent back and said, "There!" He had fixed the last wire. With trembling fingers old Jessica felt on the bed for the ear-phones, but before her hands touched them she stared at her aged husband with tear-filled eyes. The old man, with his hand to his ear, was listening at the window, and we heard all too clearly the sound he heard. It was a newsboy running through the street.

"Wuxtry! Wuxtry paper! Wuxtry!" he was shouting. "Great excitement! Feller invents a new radio circuit! Wuxtry! Feller invents a new radio circuit."

With a cry of distress John Hetterby reached for his mother, but he was too late. In her throe of agonized despair she had tied herself in a knot and, as she straightened out, her backbone snapped in three places. She had stood all the radio-set remaking she could. She was dead!

But old Samuel Hetterby was tottering down the stairs, an eager light in his eyes. "Boy, wait! Boy, wait!" he called as he tottered after the newsboy.

Roy Jordon's Station

(*Continued from page* 155)

entertaining visitors. A pair of Baldwin & Murdock phones are employed most of the time. The power supply for the receiver, amplifier and loud-speaker consists of two high amperage Willard Storage Batteries, with a third battery held in reserve. I use separate "B" batteries for the amplifier tubes. As will be noticed, all controls for the "A" and "B" batteries, Magnavox and battery-charger, are arranged, conveniently, along the desk front. To the operator's right, and within easy reach, is the "mill," which is used a great deal in copying. Reception on this set is as good, I believe, as any I have ever heard. Have received broadcasting stations in 32 states, on both the Atlantic and Pacific coasts, and the Gulf of Mexico, besides hearing regularly from four sections of Canada and Havana, Cuba. I have heard amateur signals from nearly all districts. When using the large G-R coils, I hear several high-powered stations, but to date have identified only NSS and YN. I am planning a small C.W. set, for the near future, and hope to have same installed and working before summer. The cage antenna was designed early in the fall, with this end in view. I should like very much to correspond with other bugs using honeycombs and apparatus of the same type as mine.

Radio News Laboratories

(*Continued from page* 165)

On account of their small size and light weight, the phones may be worn a long time with comfort. The total resistance was found to be 3,186 ohms. The shells are of metal with black caps of insulating material.

Arrived in good packing.

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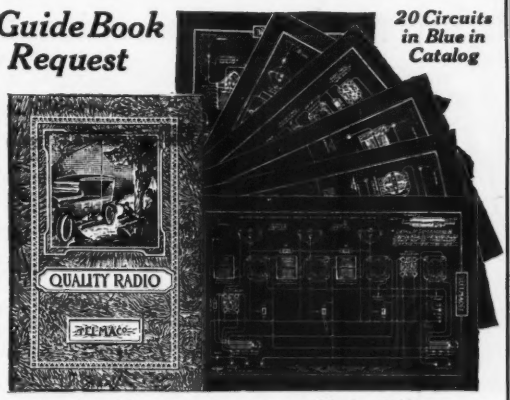

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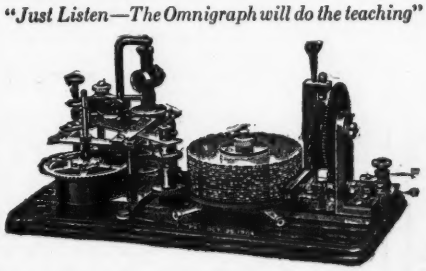

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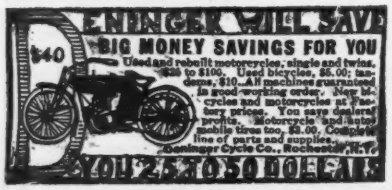

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How Bertha Brainard "Broadcasts Broadway"

(*Continued from page* 134)

or stars, author of the book and lyrics, and a brief and interesting summary. The conclusion is a short paragraph on the types of persons who might be interested in this particular presentation.

BROADCAST INCREASES AUDIENCE

Letters to Miss Brainard indicate that her informal talks have had exactly the result that she anticipated. As she frequently adds to her outline a description of unusual gowns or stage-settings, those who cannot get to see the plays at all feel that they have been visualized for them, while those who make periodic visits to the big town, as buyers, etc., know when they come here just what there is on Broadway to appeal to their tastes, and so get the utmost enjoyment out of their time and money.

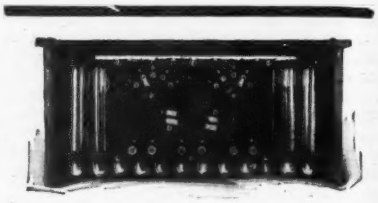
But when in one of the charming new studios of WJZ or WJY, Bertha Brainard stands before the great globe in which a microphone is cleverly inserted, and Broadcasts Broadway "to the world," she is performing only a part of her interesting duties. An equally important activity is that in which as A.B.N. (Announcer Brainard of New York) she broadcasts Broadway productions directly from the stage and wings of the theater.

When some production has been brought particularly to her attention Miss Brainard sees the show. If it strikes her as being proper material for her widely varied audience, she brings it to Mr. Poponoe's attention. His approval obtained, the next stage is to gain the manager's permission to broadcast. Once he agrees, Miss Brainard sees the play four or five times from the front, notes costumes, scenery and action, and particularly times every detail, such as overtures, curtains, and dances. She then works out a careful introduction covering the same main details as in her other talks—that is, the author, producer, cast and a summary of the scenes to be broadcast. She also explains anything in the action which may tend to confuse those hearing the words but not seeing the accompanying action; for instance, a burst of applause always marks Miss Ethel Barrymore's first appearance on the stage, and the listener-in would naturally be unable to account for this. Or in a musical comedy, the dialogue is interrupted by a dance, so Miss Brainard speaks of it in advance. Stage settings and costumes come in for a particular emphasis in this type of broadcasting, and here our announcer feels that a woman certainly has an advantage over a man announcer, since she observes clothes and other accessories so much more naturally.

"I think," she smiled at me, "that a man saying, 'Miss Peterkins is wearing a black velvet gown with a rope of pearls,' would be just *too* sweet!"

SPECIAL WIRES CONNECT STAGE TO STATION

In order that Station WJZ broadcast directly from the stage, the Western Union gives them a special direct line from Aeolian Hall to the theater. To the end of this heavy wire the Radio Corporation engineers attach two finer wires inside the theater. One of these is connected with the stage microphones, one with A.B.N.'s special microphone in the wings, all of which are joined to a portable voice amplifier. The microphones on the stage, which may number anywhere from two to five, are almost always placed down by the footlights and are quite invisible to the audience. If there is an unsual amount of work done toward the back of the stage, one may be placed



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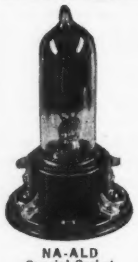

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there, and two are occasionally attached to the fronts of the stage-boxes. Usually, however, those in the footlights suffice. When Miss Brainard finishes talking through hers, it is switched off, and those on the stage thrown open. This change may be made either way at any time during the performance, so that she may talk during the intermissions, or explain during one of the aforementioned pauses exactly what is transpiring.

So keen are the stage transmitters that listeners-in may even hear the click of a telephone receiver, or the staccato tap-tap-tap of a dancer's heels as she does a spirited Spanish dance. Engineers in the wings keep the receivers on constantly, so that they can judge how the sound is going out, and the transmission is kept on the mark by means of their portable voice amplifier.

At perhaps five minutes before the overture begins, Miss Brainard, standing in the wings on the prompt side of the stage, begins her carefully timed introduction. The house electricians watch her, she raises her hand, and simultaneously with her last words the overture begins, her microphone is switched off and the stage microphones are switched on and for the next hour or two, "The Play's the thing."

Ordinarily a large company is not told in advance that they are going to broadcast, and learn that fact only as they are about to go on. Then excitement reigns, and the chorus immediately begins to wonder whether mother and wifie and little brother are listening in. Of course the entire company plays at an unusually high pitch that night, realizing that their audience is unlimited, so that an especially fine performance is presented.

ACTORS SUBJECT TO "BROADCAST FRIGHT"

Miss Brainard tells many interesting anecdotes about the effect produced upon the actors when told what is about to happen. Even the greatest among them are not immune from the excitement, and are for a little time at least a trifle nervous. When the "Laughing Lady" was sent out, hardly a voice was natural for the first few minutes and even Miss Barrymore talked at a mad pace. The effect seems to be much the same as on a first night, for the company is so impressed by the size of its audience and the distances to be reached that they feel unsure of themselves for a brief space. Mr. Wallace, the publicity manager, relates that on the above-mentioned occasion Mr. Harrison Peters hoped that no outrageous offers would reach them from Finland!

It is also circulated that when one very successful play which had already been enjoying a six months' run was broadcast, some of the principals were found on the stage before the curtain went up, and one of them was saying.

"Let's just run over this scene. I don't feel quite sure of the lines!"

The great majority of the actors, particularly the stars, welcome the innovation as a great and interesting advance in the art of the theater, and rush off into the wings between their scenes to listen-in on the engineer's phones. Their greatest regret seems to be that they cannot hear their own voices as they go out. Some of them even say a word of greeting at the end of the performance. One youthful star, who has made a particularly strong and lovable appeal this winter, became so nervous while doing this that quite unconsciously he hugged Miss Brainard with his left arm as tightly as possible during the whole speech, and gazed at her in dumb amazement when he found himself in that position as he concluded.

MANY PLAYS ALREADY BROADCAST

The musical comedy artists seem to feel the strain less than the others, and will play just as high if Mr. Gus Edwards is re-

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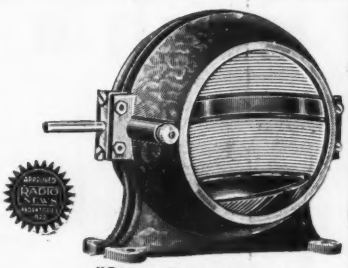

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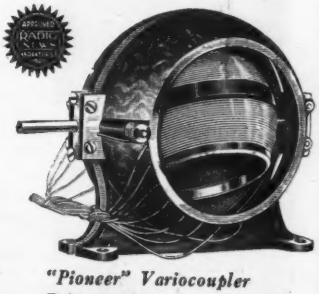

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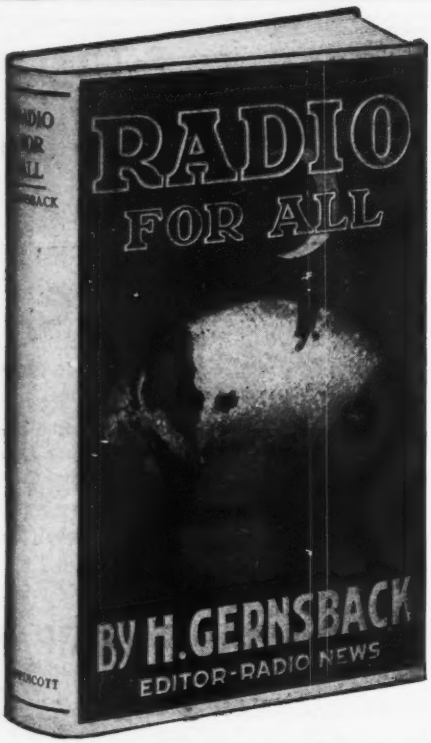

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Experimenter Publishing Co., Inc., 53 Park Place, New York, N. Y.

ported in the house as they will for a radio audience.

The first play to be broadcast in this fashion was "The Gold Fish" in which Miss Marjorie Rambeau was starred last year. Since then a great number have traveled far through the air, among them such popular attractions as "The Old Soak," "Sally, Irene and Mary," "The Dancing Girl" from the Winter Garden, "Caroline," "The Fool," "Romeo and Juliet," with Jane Cowl. The majority of these have broadcast only a portion of the play, but some of them have gone out in their entirety, including such fine productions as 'The Mikado" by the De Wolf Hopper Opera Company from a Newark theater; the Augustus Thomas production of "As You Like It"; and one of the biggest coups of all was "The School for Scandal," which the Players' Club presented with an all-star cast containing John Drew, Ethel Barrymore, Richard Mantell, Walter Hampton, and many other notables.

From this impressive list of plays, producers and actors, it is obvious that this broadcasting of plays must have justified itself not only from an artistic and recreational standpoint but from a business standpoint as well. When Miss Brainard conceived the idea in the spring of 1922, producers laughed at her and predicted that such a procedure would result in empty theaters. To one such man she said:

"This thing is going to be a success just as all the other broadcasting has been. Why not be one of the first to put it over? If you don't you'll come to me within a year and *ask* me to do one of your plays."

And he did.

Statistics are to be had for the asking from any of the theaters which have broadcast, indicating the numbers who have come to the box offices for tickets stating that they heard the play on their radio sets and felt they had to see it. Gallery and balcony receipts especially show results. On one occasion 16 men sat in their club room and heard part of a performance through their loud-speaker. So surprised and impressed were they with its enjoyable qualities that they suggested the play for a club outing at their next meeting, with the result that the club took the house for one night.

Producers to a man make the obvious answer to questions on the value to them of this work.

"It's the greatest advertising stunt that has yet been invented, and if it did not pay we wouldn't be doing it."

And ordinarily they add:

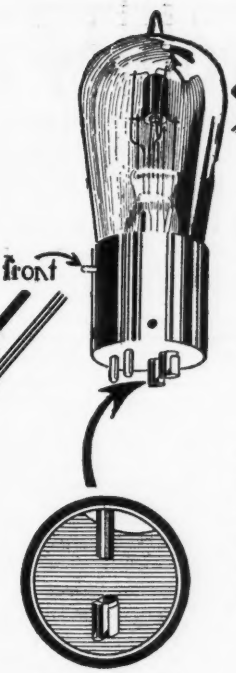
"Of course, Miss Brainard is largely responsible for its success. She seems to know what the public wants, has the personality to put it over, and has the ability to think on her feet, which is essential to any undertaking."

The only possible objection which could be made to this type of broadcasting is that which was made in the beginning by those producers who held out against it, namely, that hearing the play in this way, there would be no incentive to visit the theater, and so the theatrical business would be ruined. I think Mr. Charles D. Isaacson, who has broadcast over two hundred fine concerts, answers this most ably when he says:

"Human beings will always be more interesting than their pictures or voices. I may telephone to the woman I love and listen to her voice over the wire, and I may lift her photograph and gaze tenderly upon it, but I prefer to be with her herself. . . . When people are listening to the radio they are not being fully satisfied and never will be, not while human beings are in existence."

DON'T WORRY

It is comforting to us radio fans to know that these bandits we read about are looking for people with money.



Different tubes require different capacity fuses. When ordering state exactly what tube fuses are for.

"A Chinaman's Chance"

on keeping your tube is about what you take in operating a bulb set without the protection of the

RADECO
SAFETY FUSE
(Patent Pending)

—a risk that's entirely unnecessary when the Radeco Fuse, slipped on the filament terminals of the tube makes "blowing out" absolutely impossible, even by accident. Fits any standard tube used in any standard socket. Does not affect efficiency of set.

50c each

At your Dealers or by Mail

RADIO EQUIPMENT CO.
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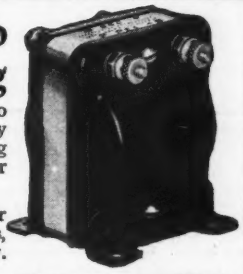
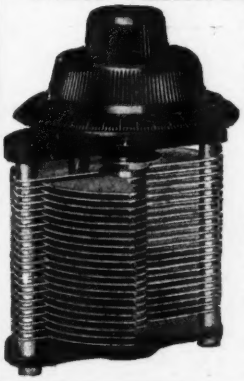


"United" Variable Condensers have a new vernier dial assembly, original with us, that makes fine tuning a joy.



43 plate.....$6.50
23 plate..... 6.00
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Postpaid.

Vernier alone; can be attached to any plate condenser by drilling one hole.. $2.50

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Classified advertising rate fifteen cents a word for each insertion. Ten per cent discount for 6 issues, 20 per cent discount for 12 issues. Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than 10 words accepted.

Objectionable or misleading advertisements not accepted. Advertisements for the October issue must reach us not later than August 1st

THE *Net Paid* CIRCULATION OF RADIO NEWS IS OVER 200,000

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Automobile owners, including Fords are using Singer Automatic Priming Cups, because they give instant starting, reduce carbon, and save 30 per cent gasoline or money refunded. Trial set $1 postpaid. Agents wanted. Fortune for good hustler. 823 Heed Building, Philadelphia, Penna.

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Learn Chemistry at Home—Dr. T. O'Conor Sloane, noted educator and scientific authority, will teach you. Our home study correspondence course fits you to take a position as chemist. See our full page ad on page 183 of this issue. Chemical Institute of New York, 66 West Broadway, New York City.

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Sport Cars, fast, saucy, hug the turns and stick to the road—make you glad you're a Ford owner. Can easily be built by aid of life-size "Red-I-Kut" patterns and picture instructions. The "Pal" system delivered complete with pressed metal streamline tail for $6.40. Garage men make big money building them. Send 5-cent coin for prospectus on making sport cars—"Jiffy" Tops and "Gosum" Windshields. Kuempel Co., 320 Kuempel Bldg., Guttenberg, Iowa.

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The How and Why of Radio Apparatus, by H. W. Secor, E. E. This newest book on radio matters fulfills a distinct gap in wireless literature in that, while the treatment is made as understandable and as free from mathematics as possible, it at the same time incorporates a wealth of technique and instruction for the Radio Amateur—the Radio Operator—the Installation and Designing Expert—as well as teachers and students of the subject in general. A very broad field has been covered by the author, at the same time giving a great deal of information not found in other text books. If you are engaged in any branch of the Radio or allied arts at all you will surely need this latest contribution to radio literature, which is destined to be found on every radio man's book shelf before long. A glance at the following list of chapters gives but a very scant idea of the extensive and useful radio knowledge provided in its text: The Induction Coil; The Alternating Current Transformer; Radio Transmitting Condensers; The Spark Gaps; Radio-Transmitting Inductances; Radio Receiving Tuners; Radio Receiving Condensers; Detectors; Telephone Receivers; Radio Amplifiers; Construction of a Direct Reading Wavemeter and Decremeter; Antenna Construction; The Calculation and Measurement of Inductances; Appendix containing very useful tables, covering all subjects treated in this very unusual book. This newest of Radio Works, cloth bound in Vellum de Luxe, Gold Stamped and Hand Sewed, has 160 pages. Size of book, 6x9 inches. The How and Why of Radio Apparatus. Postpaid, $1.75. Experimenter Publishing Co., Book Dept., 53 Park Place, New York City.

Experimental Electricity Course in 20 Lessons. By S. Gernsback and H. W. Secor, E. E. A course of the theory and practice of Electricity for the Experimenter. Every phase of experimental electricity is treated comprehensively in plain English. New experiments are described and explained and nearly every application of Electricity in modern life is given. 160 pages—400 illustrations. Flexible cloth cover, 75c. postpaid. Stiff cloth cover, $1.25 postpaid. Experimenter Publishing Co., Book Dept., 53 Park Place, New York City.

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Amateur Agents wanted in every city and town to sell radio apparatus. A few stocking agencies still open. Delfelco, 12 Meeting Street, Pawtucket, R. I.

Bargain: All parts for Super-Regenerative. Frank Foster, Nocona, Tex.

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200-20,000 Meter Receiver including Radiotron $35.00. Two Step Amplifier $22.00. Smith, 4416 Market, Philadelphia, Pa.

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Detectives Needed Everywhere. Work home or travel. Experience unnecessary. Write, American Detective System, 1968 Broadway, N. Y.

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Used Correspondence Courses only one quarter original price. Free bargain price list 1000 courses. Courses bought. Students' Exchange, 45 West 42d St., New York.

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Stamps—50 varieties, Brazil, Peru, Cuba, etc., 10c. 50 different U. S. 25c. 1,000 hinges, 10c. 1,000 mixed, 40c. List free. C. Stegman, 5956 Cote Brilliante, St. Louis, Missouri.

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Telegraphy—Both Morse and Wireless taught thoroughly and quickly. Tremendous demand. Big salaries. Wonderful opportunities. Expense low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, M St., Valparaiso, Ind.

Learn Wireless Code quickly, easily, cheaply. Dollar complete. Red stamp brings particulars. John Percival, 2115 York, Des Moines, Iowa.

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Ventriloquism taught almost anyone at home. Small cost. Send 2c stamp today for particulars and proof. Geo. W. Smith, Room M-556, 125 N. Jefferson Ave., Peoria, Ill.

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Full Value Paid for Old Gold Jewelry, Watches, Diamonds, crowns, bridges, dental gold, silver, platinum, gold or silver ore, magneto points, old false teeth. Packages returned if our offer is not satisfactory. United States Smelting Works (The Old Reliable), 120 So. State St., Dept. 16, Chicago, Ill.

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Wanted, Live amateur agents in every town to sell radio apparatus to the users. Write immediately for exclusive territory and liberal discount schedule. No capital required. Radio Exchange, 511 Seventh St., Sioux City, Ia.

Build your sets with quality parts and get sure results. Radio Parts Co., Box 56, Dunellen, N. J.

Radio Cabinets—Better Cabinets at lower prices—Marvin B. Fallgatter, Waupaca, Wis.

Det. Tube Repairs—Radiotrons, Cunningham, DeForest, etc., at $2.75. Amplifiers $3.00, U.V. 202, W. D. 11's $3.50, etc. Quick service, prompt deliveries and satisfactory results guaranteed. S. Strobel & Co., 3923 N. 6th St., Philadelphia, Pa.

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Marvelous distance hook-ups, just perfected, cheap and simple. Only Ten cents. S. K. W., 10 Westwood Drive, S. F., Calif.

Boys! Don't Overlook This. The "Rasco" Baby Detector. Greatest detector ever brought out with molded base. Fully adjustable. See former advertisements in this publication, or our catalog. Detector with Galena Crystal, complete 50c, the same detector with Radiocite Crystal, 75c prepaid. Send for yours today. Radio Specialty Company, 96-98 Park Place, New York City.

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For Immediate Delivery—Tubes, Magnavox, Westinghouse Receiving Sets, Phones, Condensers, Rheostats, Variometers, Couplers, Panels, Transformers, V. T. Sockets, Dials, Switch Points, and full line of parts. B. B. Electric Co., Galva, Ill.

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Tweet Loop Arrangement for long-distance Broadcasting and D.X. reception. No Radio Frequency—good work on detector only. Very simple. Description and diagram for one dollar. T. J. M. Daly, Little Rock, Ark.

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Magnavox Type R3, Latest nationally advertised models in original sealed factory cartons. List $35. Special introductory offer $25. Radio Central, Dept. R, Abilene, Kansas.

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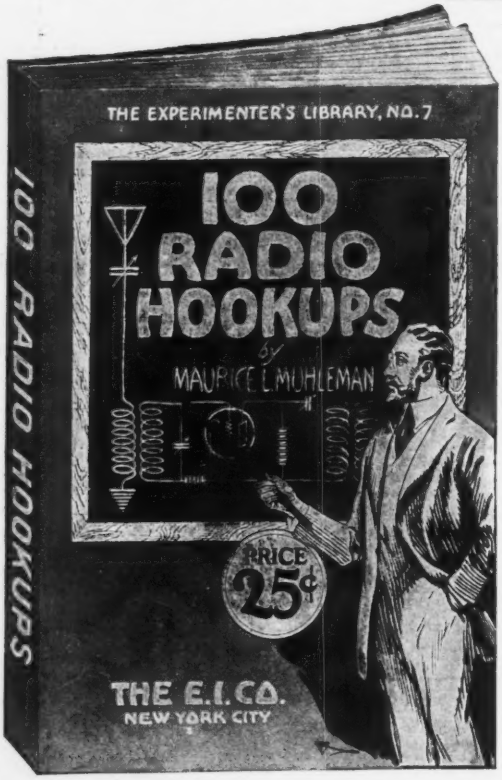

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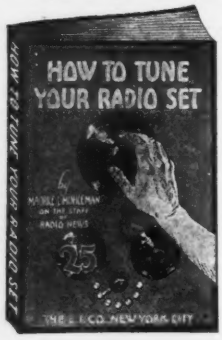

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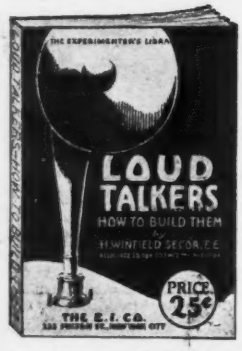

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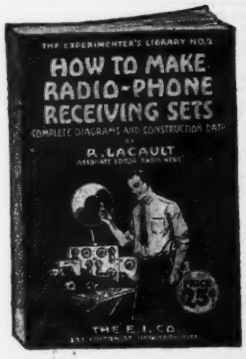

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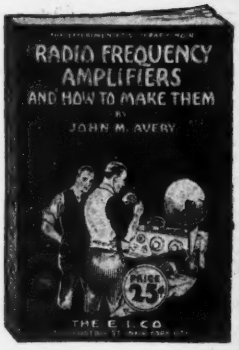

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